

TEACHERS' MANUAL FOR

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Science through the Year

CRAIG AND DANIEL

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TEACHERS' MANUAL FOR

Science through the Year

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TEACHERS' MANUAL FOR *Science through the Year*

FOREWORD: OUR WORLD OF SCIENCE

"It is no longer possible for us to ignore science in the elementary school if we are to discharge our full responsibilities as teachers," a superintendent of schools said recently to his teachers. In these words he expressed the view of thousands of parents in the United States who have become convinced of the great power of science in this modern world.

Unquestionably teachers in the elementary schools wish to meet the growing demand for science. But many of them are hesitant about teaching science because they recognize a weakness in their own background. The basal books in the series **OUR WORLD OF SCIENCE** and the accompanying Manuals have been written to meet the needs of classroom teachers, whether they have had previous training in science or not. The program of science presented in this series is one in which teachers can learn science with their pupils.

Reasons for Teaching Science

A moment's reflection is sufficient to indicate that there is no part of the elementary-school curriculum that has more important contributions to make to the present and future welfare of the nation and of the world than has science. In the following paragraphs are discussed briefly a few of these contributions.

Science makes it possible to abolish poverty. Geologists have learned a great deal recently about how to explore the earth for basic material resources. In cases where raw materials for some substances are scarce, chemists have learned ways of making synthetics which will serve all the purposes required of the original substances. This is illustrated in the manufacture of synthetic tires and quinine, for example. Chemists strive to make new substances from raw materials that are found in abundance, such

as clay, farm produce, and coal tar, thus providing new substances at a very low cost. In this way industry is promoted, more people are given employment, and the new materials are made available to increasing numbers of people. Will the children in our classrooms be prepared to utilize wisely the great material resources of the earth?

Science makes it possible for us to eliminate backbreaking toil. A few years ago most of the work of the world was done with muscular energy. Today we have learned to harness vast stores of energy to machines that may be operated by the pressing of a button. These laborsaving devices can be used in our homes, in factories, and on the farm. Tasks which took hours or days to accomplish can now be completed in a simple operation, and thus more hours are provided for recreation. Will our children be equipped to make intelligent adjustment to the vast supplies of energy and new laborsaving inventions which are daily being made available?

Science makes it increasingly possible to improve the health and safety of the peoples of the world. One of the tasks of the children in our classrooms will be to see that the discoveries of the scientist make a life of good health and freedom from accident available to all.

Science makes it possible for hunger to be abolished. Many authorities contend that an ample supply of food can be raised for all the people of the world by using the improved methods of agriculture which have been discovered in recent years. There is, however, a grave danger that humanity will face increasing periods of famine if it does not soon learn to save its great soil resources. Will our children have the vision to plan for an ample world food supply, or will they through ignorance cause new periods of famine?

Everywhere we turn we see science offering to humanity a higher standard of living in the form of improved food supply, recreation, transportation, communication, and health for all. This improvement, secured on a world-wide basis, would eliminate the chief causes of rivalry between nations and would help to promote permanent world peace.

The United States, as a result of recent events, has assumed a unique responsibility for world leadership. American children must be encouraged to have high ideals of service to humanity, and they must know how to put their ideals into operation on a democratic basis. They must be made to realize the responsibilities and opportunities that are theirs because they are Americans. They must discover while they are young the importance of science and must learn how it can be used to promote world welfare.

The record of the past indicates many fatal errors. Depressions, wars, destruction of valuable soils, pollution of streams and waterways, wastage of mineral resources, introduction of crop pests, have left their mark. With them have come needless poverty and ill health. The elementary school today is responsible for the development of a generation that will be wiser than past generations. Children must learn to realize the power that man has secured through science for the development of a civilization superior to their own.

The task, then, of the elementary teacher in teaching science is clear. Failure on her part to open up the avenues of science to the natural drives of children may result in citizens of tomorrow who are poorly prepared for the adjustments and responsibilities of the atomic age.

The Use of Books in the Teaching of Science

As much as possible the teacher should work with the children while they work, read with them while they read, discuss matters when they discuss them. In other words, the teacher should be a member of the group, learning with the children in a natural situation instead of watching their activities as a bystander or outsider. In all this work the basal book in science can lead to dynamic motivation and vitality of instruction.

The Development of an Informal Working Situation. An informal working situation in teaching science brings good results. It provides an opportunity for children to express their own ideas and to develop lines of interest.

This need not be interpreted, however, as a loose and undisciplined procedure. Science in itself has its discipline, which grows out of the scientific method and attitudes, and the teacher¹ should be keenly aware of the relation of method and attitudes to desirable social behavior in children. If this awareness is applied in science teaching, the teachers of a school should discover, in the work from the first grade through the eighth, a marked improvement in the ability of children to work together on problems.

In the teaching of science both teacher and children should feel relaxed. Much of the austerity found in American classrooms grows out of pressure and haste, which are not in keeping with the rhythm and tempo of child life. If the teacher will remember that the very nature of science calls for discovery and open-mindedness, she will lose the fear of admitting an error in her own thinking. She need have no reluctance in stating frankly that she is learning with her pupils and that there are many things she does not know. The true scientist is learning when he is making discoveries.

Reading in Science Teaching. Reading in the science book should lead to other types of activities, such as discussion, performing an experiment, and planning a science excursion. These activities in turn will cause the children and teacher to go back to the basal book or to supplementary material for information and for new interests and subjects. Many teachers find oral reading useful in science teaching.

As much time as is needed should be taken to clear up each thought. The teacher should allow the child to work important ideas found in the basal books into his thinking through the use of such basic drives as curiosity, imagination, and manipulation. The use of children's natural drives need not place the teacher in an embarrassing position, since in an informal teaching situation children can help one another.

It should be noted that this kind of work does not call for rapid reading. In fact, it may mean slow reading, with much

¹Gerald S. Craig, *Science for the Elementary-School Teacher*, pp. 13-19, 30-36. Ginn and Company, Boston, 1940.

consideration of a single sentence, paragraph, or page, and the relating of content to the children's observations and experiences. The way in which children should use books in science is quite different from the way in which they read a book of fiction, such as a storybook. In science one is seeking truth, and truth is not secured through superficial reading.

Discussion and the Use of Basal Books. Discussion in science can grow out of the use of books. A child or the teacher may have a question about something that has been read. There may be an incident which a child or the teacher wants to add to illustrate a point. Someone may attempt to explain a statement or to add more content to make a point clear. Another may propose the making of a sketch or other art work to illustrate a point. In all this, books will serve to stimulate discussion. Basal science books will be useful also in checking the accuracy of the discussion.

A discussion may last only a few minutes, or it may profitably continue for some time. Teachers should strive toward the improvement of discussion; with younger children discussion is fragmentary and impulsive; with older children it may be characterized by high qualities of critical-mindedness and intelligent planning. Children can secure no small training in learning to discern the difference between reliable and unreliable information as a result of science education in the elementary school.

In teaching science we are concerned primarily with how to find the truth. The process of finding the truth is one that the teacher must share with the children. An authoritative book in the hands of a child serves to assist both him and the teacher in discovering the truth. The teacher should ask from time to time such questions as these: "How can we find out? Are you sure? How can we get the answer? Can you prove it? Why do you say that? How much of what you said is true? What does it mean to you?" It is to be noted that the teacher's primary task is not to answer questions but to help the children find the solution.

Experiments and the Use of Basal Books. Children in the elementary school should become aware of the meaning of experi-

mentation. OUR WORLD OF SCIENCE is filled with suggestions of experiments which can safely be performed by children with equipment that can be obtained in any community. An experiment should be seen as something more than a funny trick or magic. Attention should be focused on what the experiment is to prove. Discussion forms an important part of experimentation in science. It is frequently wise to repeat experiments. Finally, the conclusions developed through the use of experiments should be checked with authoritative books whenever possible.

Field Excursions and the Use of Basal Books. At all times the content of the book should be closely related to what is going on in the community. One means is the field excursion. A field excursion may be short or long, depending on its purpose and the locality to be visited. Sometimes a trip may be made to the heating plant in the school basement, to the fuse box, to a fire extinguisher in a near-by hall, to some vantage point to observe the change of seasons, or to a suitable place to observe the clouds and weather changes. It frequently is advisable to make a trip again after an interval in order to note changes. This is particularly true in studying seasonal changes or the procession of weather changes.

Vacant lots, quarries, gravel pits, road cuts, plowed fields, meadows, woods, orchards, barnyards, are particularly good places for observation. The study of construction work, such as that of new buildings or new highways, power lines or telephone lines, provides opportunity for observation for children at all levels. Then, too, the work of the custodian or janitor of a school building has its scientific aspects, which give children opportunity for useful observation. How the various services, such as water, gas, telephone, electric power, enter a building is usually fascinating to children. In this work the janitor can be of valuable assistance to the teacher and children.

Children may need to collect material on a field excursion. This should be done only with a sensible view of conservation in mind. One of the most important meanings of science is the wise utilization of materials—conservation. Plants and animals

should not be brought into the classroom unless they are to be studied and cared for properly.

It is not necessary that the teacher be able to identify the various plants and animals by name in order to conduct a successful excursion. Many good field excursions have been conducted in the elementary school with only a minimum of identification. As a matter of fact, very few scientists or naturalists are capable of identifying exactly a wide range of objects.

New Challenges Needed from Time to Time. While emphasis has been placed on thoughtful rather than on rapid reading, the teacher should be on the alert to see that the work proceeds at a pace challenging to the children. One way to accomplish this is to move on to new aspects of the subject under consideration or to new subjects. A function of a good science book is to provide new, challenging, and vital subjects for children. Careful observation of the behavior of children will give the teacher indications of whether the children are ready for new material.

Science for All the Children

This discussion suggests how important it is that everyone in a democracy, whether scientist or layman, should have an understanding of the place of science in society. Science is a powerful tool which can be used for good or for evil. If democracy is to survive, the common people must become aware of the potentialities of modern science in a world community. To produce this awareness seems to be uniquely a task for the elementary school, since the elementary school is the school of the people. The teacher, then, will need to make certain that science is made to function in the thinking of all the children. In this way the elementary-school teacher becomes an important factor in the destiny of our nation and the world.

GERALD S. CRAIG

General Suggestions

Science through the Year is designed to give young children a better understanding of their environment. Emphasis is given to plant and animal life and to the adaptation of living things to seasonal change. Some fundamental concepts concerning the common physical phenomena which we encounter all about us are presented. The idea of the vastness of the universe is introduced, and a beginning is made in developing an appreciation of the earth on which we live.

In addition to reading the book there should be ample opportunity for the child to experience through discussion, observation, and experimentation those things that are discovered through the printed page. It is not sufficient for the child to read about the turtles, frogs, snakes, and other animals in the pond or in the park. He must be given the opportunity to see, hear, and sometimes even touch the creatures read about. It is not sufficient to look at the picture of a cocoon to gain an adequate idea of what it is; the cocoon must be seen in its natural surroundings.

No matter where a school may be located, the out-of-doors can always be used. If the school is in the country and happens to be near a brook or pond, the location is ideal for science experiences. But even in the city many places can be utilized. Many large cities have some area where there is a brook, or pond, or woods. Failing to locate such a place, one can always visit a local park and find there many of the things described in the book.

If the school has any grounds at all, these can be used to good advantage. Some adults find enough material for study in a few square feet of land to keep them occupied for years. While children are not expected to be so resourceful, it is still true that they can find much to study, or to stimulate study, in the small amount of garden space usually found around a school building.

If the teacher should happen to be located in a place where the school authorities frown upon or even forbid field trips, she should not feel discouraged. Encourage individual children to experience

the ideas discussed in class, and have them share their experiences. Set up your own "science environment" in the classroom, using extensively terraria, aquaria, and exhibits of leaves, flowers, seeds, and so on. Sometimes when the purposes of field trips are fully explained and understood, school authorities are more inclined to encourage them.

Science through the Year should not be used exclusively as a reader, for it was not written for that purpose. It is a science book. When an experience is suggested or described, have the children enjoy it. If it is boiling water to see that a white cloud forms and that the steam near the spout is invisible, boil some water in the classroom and have the children see and observe. This practice cannot be recommended too strongly, for it is only through such actual experiences that one will come closer to realizing the larger objectives of science.

Reading has a real place in science; but it must be purposeful. Reading should be done to answer a question, to find out what to do, to check information, or to motivate a learning situation. Use *Science through the Year* as a source of ideas, problems, and activities for the class. Use it to challenge children. Young children like to be challenged; they like to experience the feeling of success that follows the solving of a problem, or that follows the learning of something new.

The book has a liberal number of illustrations. These were planned with much care, and have been done with great accuracy. It is not sufficient to tell a child to look at a picture, for he may obtain fallacious ideas from a casual glance. The picture and text on each page are designed to complement each other. Use the pictures to elicit conversations that call for words which will later be read in print. Use them to arouse memories in the child and to make it possible for him to comment on his own experiences—with turtles, for example. Use the pictures to give him some idea of conditions as they exist in other places besides his immediate environment. Challenge him to find what is going on in the picture. Use the illustrations extensively. More specific suggestions as to how they may be used will be given later in this Manual.

In many cases the reasons for teaching science in the elementary school are the same as those for the teaching of any other subject.¹ Science is taught in order (1) that the child may become increasingly aware of his environment,—for example, may notice the variety of life and the weather phenomena which he otherwise might take for granted and therefore fail to enjoy; (2) that he may develop a degree of initiative or independent action through observation and experimentation; (3) that he may become more appreciative of the efforts of others through an understanding of the struggles of plants and animals; (4) that he may develop co-operation and the ability to work with others; (5) that he may become more of a conservationist, unwilling to destroy useful plants and animals, understanding some of the destructive processes that go on in nature (rusting, erosion), and becoming more intelligent regarding ways of controlling these forces; (6) that he may become more healthy through an understanding of the elemental rules of health, such as cleanliness, regularity, good food; (7) that he may become increasingly able to think carefully and not be prone to make snap judgments.

It is apparent that the goals stated above are not those of science instruction alone but of all instruction in the elementary school. That is as it should be. The school is educating children to become intelligent, happy citizens, and is interested in subject matter only as it serves as a means to that end. The mastery of subject matter as an end in itself has no place in the education of children; the aim is rather to develop concepts that will give them understanding and will shape their actions, and therefore their lives, in those ways that have been found to be most desirable.

As is apparent from the text, it is the opinion of the authors that such aims may be achieved in Grade Two through the study of those phenomena that children observe daily. All children, whether they live in the country or the city, in New York or Texas, Michigan or Florida, Maine or California, know something about birds, flowers, weather, soil, air, and water, for these are

¹Gerald S. Craig, *Science for the Elementary-School Teacher*, pp. 6-11. Ginn and Company, Boston, 1940.

common to all environments. Through science, and the excursions that are an integral part of it, children will become more aware of the differences between plants and animals; they will be more observant of the clouds and of the weather that is associated with them; they will be better able to understand how the place where they live differs from the places where other children live.

The study of science often calls for the answering of a question, such as "Why are some days clear and others rainy?" or "Why do many trees lose their leaves with the coming of fall?"¹ Through the discussion that follows, the teacher has an opportunity to learn a great deal about her pupils, and also a chance to develop the proper approach to the problem under consideration. Some children may offer explanations they have thought of or have learned from parents or from other children; others may suggest that they go out into the woods to get information; and others may feel that more can be accomplished by reading. All these approaches are good. The teacher should be observant of the actions of children during such periods of challenge to see whether they are willing to make the effort to find the answer to the question or would rather let someone else do it. A child who repeatedly fails to meet the challenge needs more direction and encouragement.

It is through challenging situations that real learning develops. It is easy to challenge children through the materials of science, for science is the study of the child and the things about him. All people, young and old alike, are interested in themselves and in the forces exerted upon them which cause them to do the things they do.

Initiating the Program. It is questionable whether there can be much real learning until one's interest is aroused. The spontaneity of children is so real and strong, and the materials of science are so interesting in themselves, that the motivation of study is often easily accomplished. In a group of seven-year-olds there may be

¹Gerald S. Craig, *Science in Childhood Education*, Chap. II. Bureau of Publications, Teachers College, Columbia University, New York.

some who, through past experience, have already developed an interest in some phase of science. If so, this interest can be capitalized by having them share their experiences with the group. If there is no such interest, it may be desirable for the teacher to propose stimulating experiences. For example, interest may be aroused by a short walk around the school grounds where trees, insects, rocks, soil, grass, birds, and a variety of phenomena are abundant. Interest may be a direct result of observation in the classroom of the movements of air, of shadows, and of indoor plants, or of observation of the change of seasons, the movements of the sun, the variation in soils, and of the plants that grow in them.

From the trips and observations many questions will be asked which the teacher will probably be unable to answer, and which she should not answer even if she has the information. The questions that are raised may be written on the board and later transferred to a large chart displayed on the wall. Such a listing will serve as a program of studies and may be used as a guide for teacher and pupil alike. Instruction is more vital and meaningful when the real questions of the pupils are being answered than when hypothetical questions are brought into prominence.

Interest may also be aroused through questions asked by the teacher. For example, she may say, "Does anyone want to tell us about the trees around his house or those he sees on the way to school?" With such a beginning children will volunteer information they already possess, and this can be listed either on the board or on a chart, as directed above. This information may well become the next reading experience of the group. During the discussion the teacher may observe that opinions differ, that some children hold misconceptions, and that they do not feel sure about some points. The teacher may then, with the help of the children, list questions to work on further. Such questions may be:

1. What happens to the trees in the fall?
2. Why do trees lose their leaves when it gets cold?
3. How do trees make new leaves?
4. How many different kinds of trees are there?

Such questions may provide real and long-lasting motivation for reading, experiments, excursions, and discussions. These in turn will offer means of developing understanding, appreciation, and initiative.

Sometimes the background of a group is so limited that there is little upon which to build. If such is the case, other methods of arousing interest may be more effective. The children may be given a few minutes to look through *Science through the Year* to get a general idea of the content and of the materials of science with which they are to work during the year. They will then be in a better position to give intelligent expressions to their desires and interests. The illustrations may be commented upon. Many parts will be enthusiastically received, and, through guidance, the group may be brought to agree that they want to study one particular topic or area. Discussion will then take place, questions or problems may be listed, and the general procedure explained above may be followed.

Reading. When the textbook is to be studied, the teacher should keep in mind the fact that reading is not effective unless it is purposeful. Before they begin to read, the children should clearly understand what the problem is that is to be solved; for only through such an understanding will their reading have direction and meaning. It is important, therefore, that discussion of the nature of the problem should precede the reading of the text dealing with that problem.

The authors wish to point out some factors which will make the reading of *Science through the Year* a happy and satisfying experience. Note that the short lines on pages 7-17 will help the child to read from left to right. Note the small number of new words for each of these pages, as recorded in the "Vocabulary List" on pages 222-224. The teacher should use these words in her discussion with the children and should list them on the board as they arise. These new words are frequently repeated in the text to insure their becoming a part of the child's reading vocabulary.

Science through the Year provides the type of reading in which children may test information which they possess to find out if

it is true, as well as the type of reading the purpose of which is primarily the gaining of information. Often when children have conflicting opinions, disputes and bickering begin. No amount of arguing will settle a question of fact one way or the other. At such a time children should be directed to reading, experimenting, or observing. They will thus learn that it is usually better to solve a problem by securing full and exact information.¹

Reading has a large place in the study of science. Children need to be taught how to use books and other printed material. Even in the second grade it is not too early to begin developing the habit of checking and enlarging upon one's information through reading.

Experiments. When a scientific experiment is suggested in the book, it is, of course, not sufficient for children to read and anticipate what happens. Reading has its value in furnishing us with facts that others have discovered in their studies of nature. But it is only through experimentation and observation that we ourselves go directly to nature for the answers to our questions, the solutions of our problems. Herein lies the great value of science.

Whenever possible, children should perform the experiment themselves. If the activity is such that the materials can be left about the classroom (as when working with magnets), they should be left there long enough so that each child may use them. Sometimes, as in the case of boiling water, it is better because of the danger of accident for the teacher to do the demonstration; but, generally speaking, the activities are intentionally simplified so that the children may do them. Wherever it can possibly be done, experimentation should be incorporated in the teacher's work. Experiments should be used to find solutions to a problem, to motivate a learning situation. The inaccurate information that sometimes arises from an experiment should be guarded against by repetition of the experiment and by checking the answer with an authoritative source. Materials and equipment needed for the science work of the second grade are few indeed, and securing

¹Craig, *Science for the Elementary-School Teacher*, pp. 36-38.

them should not be difficult. See page 125 of this Manual for a listing of the equipment required to do the experiments in *Science through the Year*.

Excursions. *Science through the Year* is concerned with the surroundings of children, with rain and sunshine, clouds and snow, animals and plants, insects and rocks, air and water. Trips should be used extensively, for there are many advantages in studying phenomena in their natural surroundings.

The findings made on field trips may not be completely accurate; misconceptions are likely to arise. Always make sure of the facts obtained by checking with an authority. Tie in experimentation and discussion with field studies, for it is not always possible to carry on extensive observation in the field. It is sometimes more profitable to work out details in the classroom.

If you have not had experience in leading excursions, these suggestions may prove helpful: (1) have the children plan the trip so that they may know for what they are looking; (2) study the area to be visited by the group so that you will have some idea of what you may hope to find; (3) plan to have very short trips in the beginning and gradually, as children know what is expected, lengthen them; (4) do not have them so often that they become a bore to the children; (5) if the group is large, divide it into smaller sections and have the children select a leader for their particular section; (6) have the children formulate rules of conduct, such as (*a*) walk quietly and talk softly, (*b*) never point, for such pointing frightens birds and insects, and (*c*) consider the desires of your classmates.

Discussions. Discussion should play a vital part in science; it should enable pupils to understand clearly the topic they are studying and to see some of its implications, and it should provide an opportunity for expression and exchange of ideas.

In the desire to help orient the seven-year-old to his physical environment through directing his observation and encouraging his reading and experimentation, the teacher must remember that children vary in their readiness to participate in group discussion.

Here is an opportunity to respect the personality of each child. The full responsibility of developing a democratic atmosphere of opinion in keeping with each child's rhythm must be recognized. From nursery school through kindergarten or in his family group, the seven-year-old may have been fortunate enough to participate in very small conversation groups of two and three people and gradually to have been associated with larger conversation groups.

Observing a group of seven-year-olds about to begin a discussion, one must recognize that it has taken a long time from the beginning of babyhood until now for any one of the group to develop a sense of self as a person and longer still to sense the selves of others. In this growing process the child may have acquired the ability to see meaning in physical objects, personal possessions, living and nonliving things, moving shadows, clouds, rainfall, floating boats, machines working, wind, human needs, life, and death.

The teacher has to take a long view backward and a forward look too if she would have science truly function in the lives of seven-year-olds. The teacher may ask, "What blows?" The four-year-old may say, "Trees blow." He may think that swaying trees move the air and make the wind. At five, six, or seven he may explain many words or phenomena in terms of usefulness to himself, to others, or to objects. The rain is "to make the garden grow," "to turn a water wheel," "to wash smoke away"; "the wind blows things"; "water moves things"; "steam moves the train"; "gasoline runs the tractor."

It might be well to examine some actual records of seven-year-olds and to see some instances of how a teacher took into account a child's personality. To Walter, a child who talked a great deal but did not act in accord with the ideas he expressed, the teacher said, "You need your sweater on because it is cold in the yard." To Peter, a child highly motivated to do and act, she said, "After you put your sweater on, you may play in the yard." In a discussion the teacher might encourage Walter to test out, through simple experiments or observation, some of his many proposals. On the other hand, she might help Peter to learn to act more slowly. She might discuss with him the reasons for doing things.

In the same group Mary had remained a listener for many weeks. The teacher then engaged her in small conversation groups. One day Kathleen, Mary's friend, suggested that Mary's picture of clouds be used for the weather record. Thus children may be given status in the group by each other.

We have suggested that now is the time for the teacher to help children to create a democratic atmosphere of opinion. When the time has arrived to undertake the solution of a specific problem, the teacher may wish to encourage a lively discussion. If she listens to free discussion, she may note some of the following facts:

Opinions may be given in a dogmatic manner.

Some children are highly verbal.

Some children seek opinions of others.

Some children are willing to listen.

Reliable information is needed.

Ideas may be challenged.

Children reflect adult attitudes.

Some children rely upon guessing.

Some children want to experiment.

Some children are under tension and pressure.

Children may see the value of observation.

Some children are willing to change their thinking.

Distinctions should be made between fact and fiction.

Children may question the teacher's source of authority.

Children have misconceptions.

Misconceptions, along with sound ideas, may show growth.

Children should be encouraged to express themselves even if their ideas reveal certain errors in their thinking. The teacher may seek to have the children express themselves by making many different proposals. She may encourage children to question proposals and to give suggestions to modify them. Thus she may help to create an atmosphere of "give and take" in the discussion. She may be satisfied with a nod of assent from a quiet child. She may consider another quiet child's look of approval as being sufficient to help lead the group to the next step in action. Thus

the teacher sees that the individuals in the group are ready to record a proposed plan. She may write these plans or conclusions on the board, with some children dictating sentences or words.

Evaluation. Once an area has been explored, there remains the problem of evaluation. When children participate in making choices, plans, and decisions, they may be evaluating also. Evaluation can be a continuous process. It can take the form of an all-important teaching situation or a routine test, depending upon the attitude of the teacher. Throughout this Manual there are questions of an objective type which are suggestive of what may be done in evaluation. However, the goal in science is not the acquisition of facts, which these tests ascertain; rather it is to orient the child to his physical environment, thus making his life more enjoyable and increasing his worth to society. A more reliable criterion of appraisal is obtained, therefore, when the teacher carefully observes how the actions and reactions of the child have been altered by his study. Oral reports in which children visit another room and relate their experiences are valuable. The questions that were listed at the beginning of the experience may be answered and discussed. Children enjoy representing some of the things they experienced on their excursions. They may make a picture record of a tree they were studying, to show how it differs in the spring and fall. They may represent the layers of soil down by the brook or the variations that exist in the leaves of a single tree. Such a practice affords the teacher a tangible device for appraising understanding. She must take care not to appraise from the standpoint of art ability, but rather from the standpoint of the understanding of science ideas. A playlet written and acted by the pupils is an interesting testing means. Permitting children to exercise imagination and tell stories about the trees, flowers, birds, or insects is also of value. Imagination has an important place in the training of young children so long as they are able to differentiate between that which is make-believe and that which is fact. The teacher should guard against personification (referring to animals and plants as if they were capable of thinking, reasoning, and planning). When she hears children giving

animals these abilities, the teacher may ask, "Do you think animals can really think?" At this level, the discussion that will follow the question will probably give sufficient emphasis to the matter.

Summary

Keep in mind that any schoolteacher can teach science, regardless of previous educational experience; also that no person can be a specialist in the many fields covered by elementary science and be able to answer all the questions that will arise. Do not be discouraged by difficult questions, but rather think of them as motivation for both yourself and the children. Contrary to general belief, inability to answer questions does not lower the prestige of the teacher. Children often acquire the attitudes of their teachers. If you are interested in science, if you like to experiment, explore, and learn, your pupils may gradually acquire the same attitude.

Suggestions thus far have been of a *general* nature. The remainder of the Manual is devoted to *specific* suggestions for the various chapters of *Science through the Year*.

I. WEATHER

PICTURE STUDY

Pages 4-5. **Picture Map.** Contrary to general belief pictures are not very educative in themselves; for although children may derive some profit from merely looking at them, a great deal more can be obtained from careful discussion of them. In all study of pictures guard against allowing the activity to become a mere naming of the objects portrayed; but rather develop understandings and appreciations of what is presented.

Read the following suggestions for using the map on pages 4-5 with the children before beginning work with them, and think about making a similar picture map with your group:

Use the map to introduce the place where Joe lives and where he goes to school and to suggest what he might see as he goes from home to school.

After looking at the map the children might compare the places where they live and their ways of going to school with Joe's.

Thus children are oriented to the map in the book, and their comparisons may suggest the degree of their own orientation to their out-of-doors. As children continue to use the book, other places might be located on the map. Additions to their own map might continue.

Seven-year-olds who will be reading this book will probably have had such experiences as a trip to the city or to the country, a train ride, an excursion to the beach, a bus trip. Encourage the children to tell about their trips. The purpose of this picture map is to give them confidence that the book is about something they are already to a degree familiar with (their environment); it is to orient them partially and give them a better idea of an environment about which they have still much to learn; and it is designed to stimulate them to want to know more about some of the objects they see in the picture. The teacher might ask: "How is the picture map like the places near your school? How is it different? Can you find the school in the picture? Where are some good places to play in the picture? Where are some places you might

go to find out about animals? Where could you find insects, fishes, birds? Are there any places like these around your school?"

Work for an understanding of conditions in both rural and urban areas. If your school is in the country, it might be well to begin with the map showing Farmer Brown's fields and then talk about a trip to the city, asking such questions as: "How far did you travel?" "How long did it take you to go?" If the school is in the city, it might be well to start with the picture of the city and from there work toward a discussion of the phenomena found in the country.

It may be desirable to take a few orientation trips in the early part of the year to determine some of the resources available for study. The children might sketch the routes they followed and write the names of places where they stopped to look at something. This activity might begin with mapping very short trips in the schoolyard.

Such a map activity might have a study of direction as a part of it. North, south, east, and west might be lettered on cards and placed in the appropriate place in the room, or in the schoolyard. Children might determine the direction in which the near-by streets run and the direction of their homes from the school.

Pages 6-15. To School in the Rain; All Kinds of Weather. This chapter develops the idea of change, one of the concepts that should underlie work in science not only here in the second grade but throughout the science program of the elementary and secondary schools.

The only constant thing about the world in which we live is the continuous succession of changes. Nothing ever remains exactly the same from one instant to the next. The wind blows first from one direction and then from another. One moment there are clouds; the next moment the sky is clear. The mountains and hills are being smoothed and worn down until eventually they will be no more.

Change is a concept that requires time to develop, and it is not likely to be meaningful to young children. Nevertheless, teachers can prepare them for an understanding of change through

a knowledge of the world as they see it. The concept itself will gradually develop as experience broadens.

Among the most obvious and easily observed of the changes that occur are those concerned with weather. Weather changes are often swift and extreme, especially in the fall of the year. The first frost causes plants and animals to change their way of living; the first snow causes even more drastic changes; the first warm days of spring also cause changes that are easily noticed. Weather changes cause boys and girls to alter their ways of living. The changes are not so extreme as with plants and animals, because man has developed ways of controlling weather in his homes and public buildings. Throughout this chapter keep in mind the concept of change and make the most of all occasions that provide steps in its development.

In *Science through the Year* an attempt has been made to describe a somewhat typical weather change, and the children reading the book have opportunity to compare the weather conditions found in Joe's rural community with those they experience in their own lives.

In general the authors have attempted to keep in mind a region somewhere between southern United States and northern Canada. Some of the conditions described are found at times as far south as the Gulf of Mexico and northern Mexico.

CONTENT¹

Weather is the condition of the air, and this condition is dependent upon several factors: temperature, pressure, moisture content, wind speed, and wind direction. Even though man can do little about the weather, he is constantly under its influence to some degree. Ships may not sail, planes may not fly, crops may not be planted, outdoor motion pictures may not be made unless weather conditions are favorable. Even the most lowly citizen is affected by it, for he will wear light clothing in summer and heavy woolens in winter. His activities will be altered by changes in weather; for when it is warm his sports are swimming, tennis,

¹Craig, *Science for the Elementary-School Teacher*, Chap. IX.

and the like, whereas they are sledding, skating, and tobogganing when it is cold.

Diet changes with the weather. During winter carbohydrates, or heat-producing foods, will be dominant in the menu, whereas in summer such heat-producers will be replaced in part by minerals, vitamins, and lighter foods.

Our whims and fancies and ambitions are likewise affected by weather. During a period of low atmospheric pressure, which usually accompanies cloudy and rainy weather, one will not be so ambitious or cheerful as during a time of high atmospheric pressure and its fair-weather accompaniment.

Clouds offer rather reliable keys to weather interpretation and forecasting, for they are indicators of the amount of moisture in the air. They may be of various types, but it is usually sufficient to be able to recognize the four main classes: cirrus, cumulus, stratus, and nimbostratus.

1. Cirrus clouds are high, feathery clouds composed of ice crystals. They usually occur at heights of from five to seven miles. Since they form at the front of low-pressure areas, they may be considered as precursors of storms.

2. Cumulus clouds are the fluffy "balls of cotton" that are often associated with pleasant summer days. The flat bottom indicates the level at which condensation begins, and the height of the clouds is determined by the speed of the upward rising current. Cumulus clouds are fair-weather clouds.

3. Stratus clouds are low-hanging clouds that often cover the entire sky.

4. Nimbostratus clouds are low, dark-gray clouds that cover the entire sky. They are the ones associated with rainy days, and are those from which rain or snow falls.

Because of the varying conditions existing at various places on the earth, it is rare to see only one type of cloud in the sky. It more often happens that one area will have one form, while another will have a different type. Also one type of cloud is often changing to another type; cumulus clouds, for example, may become stratus.

Lightning is a discharge of electricity that occurs between two clouds, or between a cloud and the earth. When air rises rapidly from the earth, as it does on a hot summer's day, fine dust particles and water droplets are carried aloft. These dust particles and droplets rub together or split apart, causing friction, which results in static electricity. (A similar phenomenon also occurs when one scuffs across a rug and then touches a doorknob, or when one combs one's hair with a hard-rubber comb.) The charge, or amount of negative electricity, builds up to a high degree until it is released to something containing a positive charge, such as another cloud or the earth beneath. Contrary to popular notion lightning does strike the same place more than once. Electric-light and power companies report that their power lines (especially those in the wide open spaces of the West) are often struck ten or twenty times a year.

In case of a lightning storm tall, steel buildings are safe, for even though they may be struck several times, the steel acts as an excellent conductor and carries the electricity harmlessly into the ground. An automobile is also a safe place to be in; for the rubber of the tires insulates the car from the ground, and the lightning is therefore rendered harmless. When a person is outdoors, he should avoid standing near a lone tree or a wire fence or taking refuge under bridges and other structures. In any event very few people are ever killed by lightning, since relatively few of the discharges occur between a cloud and the earth. More of them will be between two clouds or between the upper and lower parts of the same cloud.

So-called "heat lightning" is the same as any other lightning. It appears to be different because the thunderstorm is occurring so far away that people can neither hear the thunder nor see the individual flashes. All they can see is the reflection of the flashes against the sky.

Thunder that is associated with lightning is caused by the excessive heating of the air, its expanding and then rushing back into place again. When electricity passes through the air, the air offers resistance and hence is heated to a great degree. The heating causes the air to expand suddenly, which, when the lightning

is spent, contracts as suddenly, or rushes back into place again. The colliding of the particles of the air, resulting from the sudden expansion and contraction, sets up vibrations of sound which we call thunder.

Many public buildings and homes are equipped with lightning rods. These are steel rods extending from the highest point of a building down into the ground. If the rod goes deep into the ground, it will reach the ground water and thus provide an excellent escape for the electricity, since water is a good conductor. If the building is struck the rod controls the electricity; whereas if there were no rod it would be free to go through other parts of the building and cause damage. Lightning rods also tend to prevent the lightning from striking a building by dissipating the charge in the ground and thus neutralizing the charged cloud above.

Often this point is raised in a discussion of weather: "My father says that unpleasant weather is caused by the gunfire of war and by dynamiting. The explosions shake the air so much that the water is shaken right out of it. Unpleasant weather, therefore, is always experienced in time of war, and when there is extensive dynamiting." It has been quite definitely proved that the reverberations caused by explosions have nothing to do with prevailing weather. Weather is caused by the movement of millions of tons of air, in which, because of its great mass, no man-made disturbance could effect any changes.

In connection with a study of weather the word *climate* often arises. It may be thought of as the average of weather conditions that have been experienced over a long period of time. Climate, like weather, influences man's life and activities. It has been shown, for instance, that many men who live in the temperate zones die because of impairments of the circulatory system, while in the tropics such a cause of death is rare. This is believed to be due to the fact that the heart must work much harder in cooler climates to keep the body warm. On the other hand, a large percentage of the deaths in the tropics are due to tropical diseases which are spread by insects that owe their existence to weather or climatic conditions. In other ways also the fortunes of men can be directly traced to the influence of climate.

SCIENCE MEANINGS FOR THE CHILDREN

There is a great variety of weather.

Weather changes are caused by changes in the air.

Days may be clear or cloudy, wet or dry, cool or warm.

When the temperature of the air is lowered, the moisture it contains will come out as rain, snow, fog, sleet, or hail.

A thermometer is used to measure the temperature of the air.

Rain clouds are usually dark.

Thunder is only a wave of air and can hurt no one.

Lightning can be dangerous.

One can protect himself from lightning.

Careful observing and recording of weather often helps to predict succeeding weather.

PROCEDURE

Work in science should proceed *slowly* if growth in understanding is actually to occur in children. It would seem that often, in the rush to complete a text, individual differences are overlooked and those children who cannot keep up with the pace set by others must fall along the wayside. Of course it is not wise to dwell on a section or problem after interest has waned, but it is also poor practice to cut it off when the interest is still keen and when curiosity is still at a high pitch.

The teacher may ask the pupils to look at the picture on page 12 and tell what they think is going on. She may ask if they have ever experienced the kind of weather that Joe did. She may say, "Describe the storm. What was it like? Were you frightened?" As children make contributions, she may find it useful to write them on the board. Later the teacher may print this information on a large piece of paper and label it "The Weather" or in some other appropriate way which the children may suggest. During the discussion of the thunderstorm many points that can be worded as questions may have been raised.

Misconceptions may have arisen in the course of conversation or discussion. The teacher might help the children to state these in the form of questions to be investigated. The questions listed

on a large chart, as suggested on page 12 of this Manual, may give direction to the study of both the teacher and the pupils. If desired, the questions might be listed in the order of the importance given them by the class. Such a chart might be called "Questions We Should Like Answered." See "Evaluation," page 18.

Now that the questions are listed, what is to be done about them? The children can help by making suggestions as to how they might go ahead to find the answers. If the children are not ready to do this, the teacher may make suggestions and have the class select. The teacher should strive to develop the group to the point where they are able to make their own decisions. Suggestions might be that they read in their book to see if the answers are given there, that they see if their fathers and mothers can help, that they look in other books for solutions, and that they make observations of the weather throughout the week.

OTHER ACTIVITIES

A child remembers those things which he experiences. The experience may take the form of a demonstration or experiment, participation in a discussion, an observation, storytelling, painting, drawing, or reading; but no matter what its form may be, nothing is quite so effective in learning as an actual experience.

1. After the children have observed people, buildings, trees, and houses during both clear and rainy weather, provide them with large sheets of drawing paper or brown kraft papers, crayons or poster paints, and suggest that they make pictures about "All Kinds of Weather": (a) a picture of their house when it is raining and one when it is sunny; (b) a picture of their house when there is snow on the ground and one when the flowers are in bloom; (c) a picture of a sunny sky and of a sky in which there is thunder and lightning; (d) a picture of Joe dressed in his yellow raincoat and black boots; (e) a picture of themselves coming to school in the rain, or in all kinds of weather. The drawings might then be discussed by the children in the light of the knowledge they have obtained about the weather to determine if they agree that the pictures have been drawn accurately.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Fig. 1

2. Various groups in the class can be encouraged to keep weather records. The records can be kept on large pieces of drawing paper that are ruled for the days of the week. (See Fig. 1.) Each day of the week might have two spaces devoted to it. The children might indicate on the chart (in the lower space for that day) the clouds that were seen and state whether there were many or few, or scattered, and the kind of weather experienced. Allow freedom here; some may wish to indicate a clear day by a bright-yellow sun, a cloudy one by a gray ball, and a rainy one by dots representing rain. At the same time (Monday, for example) the upper half of the next day, or Tuesday, is to be filled in to show the *forecast* they are making for that day. When Tuesday arrives, the lower space for that day is completed. If the forecast has been wrong, put a large X in that space. If such a practice is carried on by four or five groups, they will be able to compare notes and see how many of them were right and which ones were the most accurate in their predictions. Through such an activity children may be helped to observe more carefully, to see relationships between clouds and weather; and they may learn that certain ideas they might have about the weather are erroneous or true, as the case may be.

3. The days of bright sunshine might be colored in on a large picture calendar drawn by the teacher or on an ordinary commercial calendar.

4. Children may make a chart that will serve as a place for listing their observations of the weather. A heading might be, "These Things Happen Before It Rains." Depending upon the season and location, points under such a heading might be as follows: (a) it becomes warmer; (b) the wind blows from the east; (c) the sky is covered with clouds. Such listings can be made more interesting by picturization, and this should be done wherever possible. Another heading might be "How the Clouds Look" or "What Happens Before It Starts to Snow."

5. It is not expected that second-grade children will be proficient in reading thermometers; but this skill can be started. If your classroom does not have a good thermometer one can be secured from the Taylor Instrument Company in Rochester, New York. Specify a large thermometer with large numerals that can easily be read by young children. In making temperature readings keep the thermometer in the same place indoors or outdoors and make readings the same time each day. For training in reading temperatures draw a large thermometer and cut out the center as shown in Fig. 2. Place a piece of red paper behind this space. As the temperature changes from day to day, move the colored paper up or down, fastening it in place with a straight pin. Draw a horizontal line on the drawing of the thermometer to indicate the temperature for a particular day. This activity should be

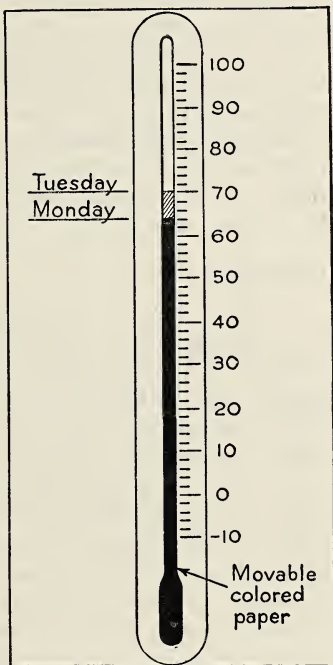


Fig. 2

carried on during intervals throughout the year to help children understand how the temperature changes from season to season.

6. Have the children stand in sunlight in the room and then stand in the shade. Is it warmer in some places than in others?

7. Have the children stand in the shade out of doors. Have them stand at the north side of the schoolhouse and then at the south side. Where is it warmer?

8. In the early morning discuss with the children what they think the weather will be like during the day. Record what they think, and then check later in the day to see if the predictions have been correct.

EVALUATION

In the teaching of science the acquisition of facts is secondary to the adjustment of the individual to his surroundings. Although testing of the usual type may be used, and there are a few such sample tests included in this Manual, one may question the wisdom of judging a child solely on the score he obtains. An effective way of evaluating is by adding new learnings to a list under the heading "What We Know about the Weather," which might be started. The teacher must guard against allowing a few children to monopolize the period. She must be alert to see that each one has grown in his understanding of the phenomena of the weather. Are children now afraid when they hear the thunder? Do they know what to do when there is lightning and what not to do, and do they do it? Do the children have some idea of what causes the weather, and do they at least partially understand why one day is different from another? Admittedly many of these points are difficult to ascertain; but it is believed that the teacher will be able to discern growth in the child if she can see that he has been brought closer to an understanding of the factors that cause weather and to a more intelligent adjustment to weather factors in his environment. It is hoped that the science meanings suggested in the beginning of this section (page 26) will have been realized.

It is now possible for the children to answer the questions they raised during the discussion described on pages 26-27 when the

study of weather was begun and which were listed under "Questions We Should Like Answered."

For the convenience of those teachers who may wish to use it, a sample test is given here. The sentences might be written on the board, leaving a blank for the required word (which is here printed in *italic type*). The teacher may prefer to make up her own sentences instead of using those offered here.

1. When the sky is very cloudy, we should wear our *rain* coats to school.
2. When the sun is shining, the air is *warm*.
3. When clouds cover the sun, the air is *cooler*.
4. *Thunder* is only a noise, and noise cannot hurt us.
5. Usually clouds that are high in the air are signs of *clear* weather.

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¹For addresses of publishers, see page 126.

II. IN THE AUTUMN

The chapter "In the Autumn" might best be used first, when children return to school after summer vacation.

Pages 16-20. A Walk in Autumn. This story applies the philosophy underlying this entire book and series; namely, that extensive study of the environment of the child is to be made wherever it is at all possible. As explained previously, this study can be made through brief trips, lasting but ten or twenty minutes. Excursions may be made to find the answers to questions raised by the children as well as to develop a purpose that the teacher has in mind.

In the autumn a purpose might be to discover the manner in which some living things prepare for winter through the various adaptations to cold weather. Other aims of a trip might be to see (a) what animals are to be seen at this season, (b) what the animals are doing now, (c) how different the animals look from the way they looked in summer.

In pages 16-20 the authors had in mind the big concept that changes are going on all about us. Some of the leaves are changing color and falling to the ground; the weather is changing and is intermediate between the heat of summer and the cold of winter; the days are becoming shorter. The falling of the leaves may be used as a departure for an elementary discussion and observation of the value of fallen leaves in preserving the land and the water supply by providing a spongy layer in the woods.

Before looking at pictures on pages 16-20 the children might discuss what is happening out of doors in their community. Lead them to suggest some of the facts that are stated in the first paragraph on page 17. Let children express their ideas as to what Joe and other children are seeing in the picture on pages 16-17. They may express opinions as follows:

The children are looking at the trees.

The leaves are yellow, red, and brown.

The leaves are falling to the ground.

The children seem to like being out of doors.

Note the use of new words in the conversation given on page 18. List them on the board before reading. Now children are ready to read about Joe and others on pages 18-19. The teacher or children might suggest going out of doors to look for the same things.

A snake is referred to on page 18. Since it is not always possible to find a snake, it is better to have other reasons for making the trip than the sole purpose of seeing a snake. Sometimes, however, some child may have seen snakes in a certain place and may be able to lead the group to that place. If it is possible to see a snake, try to have the children notice the coloration and how it blends into the background; also the adaptation in being able to swim swiftly, if it is a water snake.

CONTENT¹

While the purpose of this section is not to impart to children a knowledge about snakes, but rather to develop the concept of change and instill a feeling for the many forms of life about us, it is believed that some information about a typical water snake will be of value to the teacher.

The water snake referred to is common to many sections of North America, although there may be some variation in markings in different parts of the continent. In its typical form the water snake is dingy-brown and rough-scaled. It enjoys sunning itself on the branches and bushes that overhang brooks and ponds; but it will slip into the water at the slightest sound, for it is very timid. Except for the smaller and younger specimens, it is not an attractive snake. The brown of the body is crossed with ruddy-brown blotches on the forward part, and on the latter these break into three series of alternating blotches. The underside is prettily marked and is either yellow or white with many bright-red irregular markings. Old specimens are uniformly dull and lusterless with a flat head, a thick body, and a general ugly appearance. They are usually from two and one-half to three feet long. They eat fishes, frogs, toads, and tadpoles; and they give

¹Craig, *Science for the Elementary-School Teacher*, Chap. XIII.

birth to living young in the latter part of August or early September, when as many as sixty young may be produced.

The teacher should help young children to overcome fears or misconceptions and to gain an understanding that not all snakes are harmful to man.

SCIENCE MEANINGS FOR CHILDREN

Weather changes with the end of summer and the approach of winter.

Leaves change color with the approach of autumn.

Many trees lose their leaves in the autumn.

Trees are not growing in the autumn and winter.

There are not many baby animals about in the autumn, as there were in the spring.

Snakes are colored to blend into the background. Protective coloration is an adaptation of living things to environment.

Most snakes are helpful to man, and it does no good to frighten or harm them.

The common water snake is harmless.

Water snakes are good swimmers. This helps them to catch food and to escape from enemies.

PROCEDURE

By means of discussion develop a desire to go out on a short field trip. Encourage the children to make a few simple rules for themselves, such as walking quietly, keeping together, not making quick motions that will frighten animals. Do not formulate many rules. Start with a few simple ones and add others gradually, as the need is apparent. Have the children determine why a trip is necessary. The reasons for making a trip might be to learn by observation the answers to questions such as these:

Shall we see plants we saw last spring?

Shall we see animals we saw last spring?

Will plants look the same as last spring?

Will animals look the same?

Will the leaves be green?
 Shall we see different plants?
 Shall we see different animals?

These can be listed on the board so children will see the symbols for the things about which they are talking, and so they will be acquainted with them, thus making their future reading more purposeful and easier.

After the trip is completed, it may be followed by having the children discuss what they saw and learned. These observations and learnings might again be listed as above. Such a listing might include points similar to these:

Many plants die in the autumn.
 The weather is cool.
 The leaves are changing color.
 Many leaves are falling.
 There are many kinds of plants.
 There are many kinds of animals.
 Many animals help man.

A check-up of learnings is often helpful in that it helps the less observant child to appreciate the multitude of natural phenomena about him. If the trip was over an area that had been visited before, the children might be encouraged to determine how it is different now from when they last saw it.

The teacher might say: "Look at the pictures on pages 18-20. Do they suggest places near you, such as a brook, pond, or lake that you could name and plan to visit?"

"What animals do you think the children might see at the pond on pages 18-19? What are they excited about?"

Let children tell of experiences when they saw animals colored like the out-of-doors they were in, such as grasshoppers in green or brown grass, and rabbits in snow or woods.

Read through page 20, stopping to let children discuss their ideas about treatment of unharmed animals.

Children need to be shown that animals have a place in the scheme of things; that they should not be killed unless they are harmful. The majority of snakes, for example, are beneficial to

man. The children at Hill Top School are interested in watching the snake; but they do not rush to catch it and take it to the schoolroom. The authors would urge the study of animals in the out-of-doors habitat wherever possible.

The fact that seasons change, that "summer is over and autumn is here," may not be apparent to young children, but they can be brought to a realization of it. A better understanding of the change of seasons might be developed by having children observe falling leaves, observe that some plants lose their leaves while others do not, determine the change in daily temperature by reading the thermometer, record the change in the amount of daylight and darkness, observe the effect of seasonal changes on plants and animals.

OTHER ACTIVITIES

1. Gather leaves from various trees and study them to note that leaves from different trees are different. There is variety in shape, color, and size. If there should be a need for it, leaves may be preserved by dipping them in melted wax, or by shellacking them.

2. Gather several leaves of one tree and, by carefully observing them, note that although they are of the same type, no two are exactly the same. There is endless variety in nature.

3. Start a listing of "Signs of Autumn," such as the one shown below. The list can be used as a reading experience to develop familiarity with words and to give practice. Note new words used in the text. Use some of these new words when possible.

Signs of Autumn

The leaves are changing color.

The leaves are falling.

The flowers are making seeds.

The trees are making buds.

The weather is cool.

The animals are storing food.

People are storing food.

4. The authors feel that animals should be studied in their natural homes; but sometimes it becomes desirable to have specimens in the classroom for a short time. If animals are brought in, they must be cared for, fed properly, and released as soon as the reason for bringing them in has been realized. Here conditions necessary to life should be considered. If it is desired that a snake be kept in the classroom, you might provide a glass-sided terrarium for it. If the animal is a garter snake, a woodland

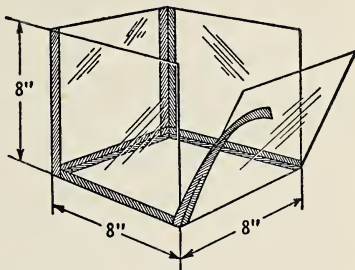


Fig. 3

type of terrarium is to be desired; whereas if the animal is a water snake, a semiaquatic terrarium should be provided. A terrarium may be made by fastening five squares of glass together with adhesive tape, as shown in Fig. 3. Keep the terrarium in sunlight, sprinkle it with water, and keep it almost covered with another glass plate. Feed snakes with fish, tadpoles, earthworms, and insects. Note the changes taking place.

EVALUATION

In evaluating use the science meanings originally listed for this section. It is suggested that the teacher refer to them and determine by observation and discussion whether the children have grown in their appreciation and understanding of them. Are the children increasingly aware and conscious of the changes that are going on about them? Are they increasingly aware that animals are adapted in various ways for living in their environment? Are they beginning to learn that there is an endless variety in nature?¹

¹For further information on variety in nature see *Science for the Elementary-School Teacher*, Chap. X.

Pages 21-26. **Birds in Autumn.** Although many animals migrate, more birds do so than any other animal. Migration is a characteristic of many species, especially those that nest in northern latitudes during the summer.

Some birds of the United States and Canada winter as far south as southern South America. Even the hummingbird, the smallest of all birds, winters from Florida to Louisiana and as far south as Panama, and spends the summer as far north as Quebec and Saskatchewan.

The reasons for seasonal migration are not fully understood. Scientists are far from agreement about the explanation. Several theories have been advanced. Two are given here.

During the summer, many birds feed upon insects which they find in the ground, in trees, in bushes, and in the air. The coming of cold weather reduces this supply because most insects are inactive in winter. The birds that depended on this form of nourishment must now change to another diet or move to a place where insect food may be had. Many children are aware that in the autumn birds fly to places where there is plenty of food and warmer weather. The search for food, then, seems to have something to do with migration.

Some scientists, however, think that migrating birds are seeking longer hours of daylight, since it is believed that the greater amount of light influences the functioning of the reproductive system. At the end of winter, when the days in the north are lengthening perceptibly, the birds begin to return to their summer residence, benefiting by the longer hours of daylight throughout the mating and nesting period.

Before the long, arduous, and dangerous migration birds feed extensively and group together into large flocks. During the journey many of them fall by the wayside. Bright lights often attract them to towers into which they crash, many die from exhaustion, and many are shot down by hunters. More and more agencies are becoming active, however, to reduce as far as man is able such hazards to migration as shooting, light towers, and the like.¹

¹See *Science for the Elementary-School Teacher*, pp. 360-367.

SCIENCE MEANINGS FOR CHILDREN

As weather becomes cooler, the birds prepare for winter.

Some birds migrate to warmer climates, while others remain through the northern winter.

Birds molt in late summer and after the mating season.

Extensive feeding is necessary before the migration so the birds may have energy for the journey.

Birds usually feed in flocks and migrate in flocks.

Birds eat many seeds.

Birds with blunt beaks are seed-eaters.

Birds scatter seeds.

Birds do not sing as much in autumn as they do in summer.

PROCEDURE

Before looking at pictures or reading pages 21-26 see if you can follow out with your children a plan similar to the plan that Miss Gay followed. Recall with the children animals they saw last spring. While on a trip, notice if your children observe that the birds are hiding, that the birds may be molting. Note whether or not the group expresses misconceptions, doubts, or questions. Ask how they could check their ideas.

Here again the teacher has an excellent illustration of the concept of change, the fact that nature does not remain constant. As mentioned previously, it is not expected that children will fully understand this concept; but every illustration presented to them aids in its development. The information on birds presented in *Science through the Year* is best understood through actual observation. The authors had a field trip in mind as they prepared the material. If it is not possible to make a field trip to see the things discussed, have the children make individual observations of birds feeding, flying in flocks, fluffing their feathers, and in other ways preparing for winter, all of which are learnings that may be added to their list "Signs of Autumn." Even if a group excursion is made, it is doubtful whether all the phenomena mentioned in the book will be seen, and the results of the excursion will have to be augmented by individual observations.

OTHER ACTIVITIES

1. The children might enjoy painting some object they saw on their trip to the woods or fields. The teacher might try to have the children represent a bird, snake, leaf, or other object the child selects, in its proper setting. Thus children may begin to see the interrelationship and interdependence of living and non-living things.

2. Have the children look up in references the names of some of the birds they have seen. It is suggested that the teacher keep in mind, however, that the purpose of science study is not the naming of objects. The activity is suggested here because children are often curious to have this information and looking it up provides practice in research, the method of science.

3. Prepare a list of some of the birds that migrate to the south in winter, and another list of those that stay in the north. Some animals are adapted for living in various climates; others are not.

4. Collect feathers that birds have molted. Study them to see how light they are, how they help a bird to fly when they are spread out, and how they keep birds warm. The children might be brought to observe the great variety of color, size, and shape of the feathers.

5. To impress upon the children the importance of conservation, and to develop in them a feeling of responsibility for the welfare of living things, the ways of helping those birds that will be with you all winter might be discussed. Suggestions might be made to build a feeding station and to keep suet in it, or to spread bread crumbs on the snow. A suggested feeding station is shown in Fig. 4.

6. This is a good time to collect nests, since the birds are now finished with them. It is difficult to identify nests accurately unless the birds are seen while making them; but by carefully taking one or two apart children may gain an appreciation of the skill the birds show in putting together the pieces of grass, hair, and string of which many of them are made. Bring out the thought that the nest is not the living place of the birds but is used only for depositing and hatching the eggs and raising the

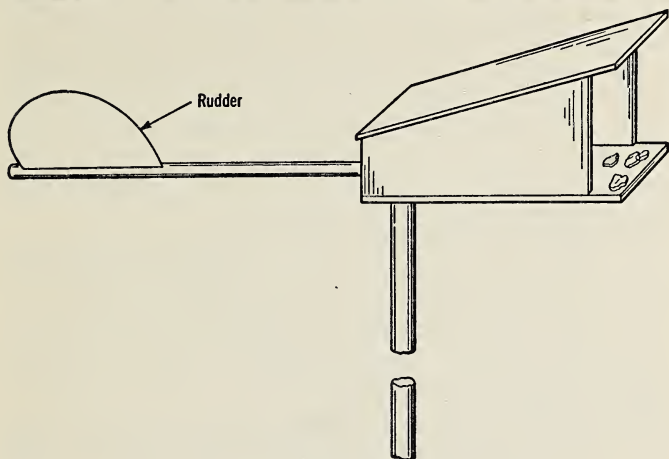


Fig. 4

young. Once the function of producing another generation has been accomplished, the nest is no longer used.

EVALUATION

Evaluation is a continuous process and should not be a distinct or separate step in teaching. The teacher will be noticing the interests of the pupils; she will be aware of whether or not they understand the ideas discussed; she will be cognizant of how they carry through their activities.

Pages 27-29. Cocoons in Autumn. Many insects, such as moths and butterflies, pass through four distinct life stages: egg, larva (caterpillar), pupa (cocoon), and adult. When the Cecropia caterpillar emerges from the egg, it is about one quarter of an inch long and is black. Like all other caterpillars, it grows by shedding its skin, the new skin stretching to its limit, hardening, and then being replaced by another one. The caterpillar makes four successive molts, or changes of skin, during which time it passes through many color changes. In the final stage it is an

enormous caterpillar, often as much as three inches long. It is bluish-green with markings of orange, yellow, and blue. It now eats voraciously for from ten to fourteen days, and then it begins to spin its cocoon, which is made of silky fibers skillfully woven into a loose matting. The caterpillar spins silk about itself until it is completely encased. It then makes its last molt and settles down for the winter, during which time amazing changes occur that produce the beautiful *Cecropia* moth.

The cocoon of the *Cecropia* moth is found most frequently in orchard and shade trees; and is often called the cradle cocoon since it is hammock-shaped and hung close below a branch.

The larvae of most butterflies do not spin cocoons but encase themselves in what are called chrysalises, which are suspended in protected places by a silk thread.

Not all insects remain in the pupal stage during the winter. Some become pupae in the spring and emerge in a few weeks, while with others the process takes place in the summer or early autumn. Other insects do not go through the pupal stage at all. The grasshopper, for example, resembles the adult as soon as it is hatched, and becomes larger by successive sheddings of its skin.

SCIENCE MEANINGS FOR CHILDREN

Many insects are adapted for life in cold weather.

The *Cecropia* moth becomes a pupa in the autumn.

The pupa is inside a cocoon.

The cocoon is not an animal but a case.

Often it is better to leave living specimens in the out-of-doors.

The pupal, or cocoon, stage is one step in the life of some insects.

PROCEDURE

Use the pictures on pages 27-28 to determine the children's attitude toward collecting animals or plant life to bring indoors. Use the pictures on pages 27-28 to anticipate what Joe and others discovered on this trip out of doors. Ask, "What do you think they will do with the cocoon? What should we do if we find one on our next trip?" Read to find out what the children did in the

situation on pages 27-29. Note new science words on page 222. Can children read with ease and satisfaction because words have been previously used in conversation? Plan a trip to a park or the woods to look for cocoons. List plans on a chart. Use the chart as another science-reading experience. Note comprehension of new science words. See "General Evaluation" on page 45 of this Manual.

To learn about cocoons and the life cycle of insects the group might make a trip into the field to see the activity going on. It may be that the children will see caterpillars and moths as well as cocoons. No doubt they will want to bring the cocoons into the classroom. Through discussion the children might come to understand that many living things are not fitted for life in the classroom, and that they do better when left in their natural surroundings. Although the pupa in the cocoon will live indoors if well cared for, it will hatch while the weather is still cold and will die because it cannot withstand cold weather.

On returning to the classroom the children might discuss the trip.

OTHER ACTIVITIES

1. The children may wish to make a map of the area of their field trip and place on it the locations where they know there are cocoons. Children enjoy making such a map, and it makes it possible for them to return to the location later on to see the cocoons, and especially to return in the spring to see that the moths have emerged.

2. Refer to the map on pages 4-5. Note autumn colors, places, the pond, the woods, and directions.

EVALUATION

Check the appreciations of children against the science meanings that were listed earlier (see page 42 of this Manual). Individual differences in amount and degree will probably be revealed. Are the children beginning to have some idea of the manner in which living things are adapted to withstand the rigors of cold, wintry weather? Are they beginning to see that it is better to

enjoy living things in their natural surroundings rather than to bring them into the classroom where they often die from mistreatment or maladjustment? Are they beginning to see that nothing is constant, and that there is a continuous succession of changes? Are they becoming more observant of the simple phenomena all about them and therefore gradually learning to enjoy their environment? Does the teacher recognize and respect individual differences among the children in the group?

If a trip to look for cocoons is taken, note the willingness of children to leave cocoons out of doors. Although the children may have been most reasonable during conversation and while reading pages 27-29, some individuals, in practice, may not yet be ready to act upon the idea of watching the cocoon out of doors until next spring. The teacher accepts this as the level of development they are now in.

Page 30. What Can You See? This page is intended to suggest to the teacher and the children some of the things for which they can look, and to suggest possibilities for caring for individual differences. It is not meant to be inclusive and to cover all the possibilities for observation. The children might discuss the suggestions, and they might be given an opportunity to exchange ideas if observations have already been made; or there might be a follow-up in a few days to exchange thoughts about some of the things they have seen after having followed these suggestions. The surroundings of children are abundant with science phenomena; they need only encouragement to become aware of them. With some direction this awareness can be developed into understanding and appreciation.

Page 31. Do You Know? Use the pictures on page 31. Ask, "What are these people doing in order to get ready for winter?" Although animals do not consciously prepare for winter, they do seem to make preparations for it, such as entering the cocoon, hibernating, digging into the mud, and so on. Man, on the other hand, consciously gets ready for winter by preserving foods, thus insuring a supply, by putting in coal or other fuel so the home will be warm, by taking clothing from the moth bags where it has

been stored, by putting an antifreeze in his car. The pictures shown on page 31 will perhaps suggest other ways in which people prepare for winter. The children may wish to make a reading chart on which to list the items. These might include the following:

It is getting colder.	We must put wood in the cellar.
Winter is coming.	We must can food.
We must put coal in the cellar.	We must get warm coats ready.

GENERAL EVALUATION

When the children have reached the end of this chapter and are taking walks and making observations, they might plan to paint a frieze to show seasonal change around them. This frieze might be several feet long (five to fifteen feet). The children might list observations, each noted with the idea of making a section of the picture, such as:

Some trees lose their leaves.	Some of the birds are quiet.
Some trees keep their leaves.	Some birds are eating before leaving.
There is variety of color in autumn.	There are cocoons on some branches.

During this activity the teacher might note the growth of understanding of the science meanings listed on pages 34, 39, and 42. This is a new situation which makes use of the past experiences of the children, of the reading, discussing, and observing they have done. It calls for a grasp of science meanings and concepts and provides the teacher with means for determining whether misconceptions have been corrected.

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FILMS¹

Snapping Turtle

Moths

¹See page 126.

III. THE EARTH

Use this chapter, pages 32-49, at any time during the year. The meanings developed in this chapter are not necessarily dependent upon preceding chapters. If some attention is given to the new words listed on pages 222-223, new science words need not make reading too difficult. This chapter might well be used during midwinter when weather conditions may prevent many trips out of doors.

Pages 32-33. We Live on a Big Ball. Children are interested in their earth, its shape, size, motions, and its relation to the stars, sun, and moon. These are factors of the environment, just as are birds, flowers, rocks, and soil.¹ In the study of the earth with seven-year-olds, actual earth measurements are not to be learned, as they will mean nothing to the child; but rather the purpose is to extend the child's concept of space, to help him appreciate the largeness of the earth, and to develop the science meanings as listed on page 47.

The explorations a child makes of the world about him begin with the cradle. Later he builds impressions of his room and of the other rooms of the house. The backyard, when first seen, is a revelation of expanse. As he matures, the child becomes aware of the other houses about him, of the barn, of streets and roads, towns and cities. These are phenomena within the consciousness of the child; but the concept of the earth is not so easily developed. *Science through the Year* takes the child by easy strides over the steps that will serve to develop the concept.

CONTENT

As mentioned previously, it is not expected that the children should be introduced to the mathematics of earth measurements, for these are so large that they will have little meaning for seven-year-olds. The information is given here so the teacher will have the material on hand for ready reference and so her own conceptions will be enhanced.

¹Gerald S. Craig, *Science in Childhood Education*, p. 41. Bureau of Publications, Teachers College, Columbia University, New York.

For all practical purposes the earth is thought of as being a ball, or sphere; but actually it is slightly flattened at the poles and bulged at the equator. It is 25,000 miles in circumference at the equator, and its diameter is about 8000 miles.¹

SCIENCE MEANINGS FOR THE CHILDREN

The earth is very large.
The earth is round.

PROCEDURE

Use the picture on pages 32-33 to introduce ideas about the earth. Wait and listen to children's comments. Earth and space concepts may be entirely new to them. For many seven-year-old children it may be their first experience in seeing a printed picture of the earth or in reading about the earth. They may say, upon looking at the picture,

It seems like a ball.
It seems like a big, round ball.

Read the two lines on page 33. Wait for comments. Questions may come, such as

How big is the earth?
How do we know it is round?
How does it stay there?

Use such questions, and also doubts and misconceptions, to motivate later reading. Note new science words listed on pages 222-223 for each new page in this chapter.

The fact that the earth is round is a new concept for most children. They often feel that if it is round one should walk downhill when he moves over the surface of it. It is also a new idea to them that the earth is large and that their sphere of action is but a small part of it.

The teacher may wish to elicit expressions of the children's interpretations of the earth. She may ask, "What do you think

¹For further information about the earth see *Science for the Elementary-School Teacher*, Chaps. IV-V.

the earth is like? How large do you think it is?" The answers received will serve to reveal ideas that the children have, particularly misconceptions, which will give the teacher suggestions as to the direction of teaching.

If the children have not already had experience with the globe, use it with pages 32-33. Now is a good time to help them become familiar with it. Using a large globe,¹ the larger the better, locate the approximate place where the school is. Place a little piece of modeling clay on this spot and stick a figure in it to represent the child. If a child has gone on a trip, the distance covered might be measured by stretching a string between the two points. The string might then be fastened to a board with Scotch tape and labeled "This is how far Tom went." With another string measure the distance around the globe, place this on the board and label it "This is how far it is around the earth." Throughout the discussion the new words that arise might be listed on the blackboard. New words could be *earth*, *distance*, *globe*, *ball*.

It is advisable to bring out the connotations of earth and soil. Children are likely to think of the word *earth* as meaning *soil*, and not the globe on which they live.

When children are acquainted with the roundness of the earth, they often think that, if it is round, one should be always walking downhill. This misconception may be partially corrected by using balls of various sizes. The idea of curvature might be brought out, and the point clarified that the larger the sphere, the less the abruptness of curvature. The teacher might go from this to the drawing of arcs of very large circles on the board. The arcs may be made so large that to all practical intents they are straight lines. Emphasize the great size of the earth and attempt to make the connection between your illustrations and this size.

The children might be told that the picture of the earth on page 32 is as one far away from the earth might see it. The teacher may wish to ask the children what they think the picture tells them. The earth is so very large and our neighborhood so very small that one cannot find the latter on this picture.

¹Simplified 16-inch globes for use with young children may be obtained from Rand McNally Co., 111 Eighth Avenue, New York City.

Pages 34-38. **The Earth Is Big.** Use the pictures on pages 34-35 and let the children name things Joe sees that are a part of the earth. Let them look out the window and name things they see that are parts of the earth. The trees, fields, hills, prairies, rivers, lakes, and oceans within the child's experience are but a small part of the earth. The expanse that one sees from a high hill or mountaintop or building is but a small part of the earth. The hundreds of buildings, streets, trees, and parks that Alice sees in the city are but a very small part of the earth.

CONTENT

The earth is composed of solids, liquids, and gases. The solid is the land part of the earth, the soil and rocks. The liquid part is composed of oceans, lakes, rivers, and underground water. The gaseous part is the atmosphere, which is as much a part of the earth as the land and oceans.

SCIENCE MEANINGS FOR CHILDREN

The earth is made of land, water, and air.

The earth is very large.

Our homes and farms are but a small part of the earth.

Our cities are but a small part of the earth.

PROCEDURE

The children might discuss places they have visited. The teacher might ask, "How long did it take to get there?" This should help to further their understanding of time and space relationships. It is effective to have the children start from where they are and gradually broaden their ideas about the earth. For example, from the school they can see many fields, hills, and valleys; or they can see many buildings, streets, and avenues. They might be asked, "What do you think is out beyond these places?" It might develop that some of the children will know that there are more fields, and more cities beyond the horizon; and more and more beyond those.

As the discussion progresses, the ideas mentioned might be written on the blackboard with the thought in mind to develop a

reading experience. The teacher should be familiar with the new words that are presented in the pages. Thus children see coming into being the written form of the actual words and sentences that they will be reading in their books.

The pictures on pages 34-36 may be used to help in developing the idea of space. Even though we can see a great deal in these pictures, the expanses shown represent but a tiny bit of the entire earth. In a similar manner the picture on page 38 may be used to emphasize that there are only three parts to the earth: land, water, and air.

Use the picture on pages 4-5 along with the picture on page 36 and the globe to help develop the concept of space.

OTHER ACTIVITIES

1. The children might talk about trips they have made and how far they went, as well as how long it took. The total distances traveled by the children might be computed and a string then stretched on the globe to represent this distance. If it happens to be, for example, one thousand miles, cut a string to represent this distance, using the scale on the globe. This string shows how far all have traveled. Cut another string twenty-five times as long to represent 25,000 miles, the distance around the earth. The two strings should be compared and the great difference, which will be apparent in most cases, should be emphasized.

2. If it is possible, take the children to a high building or to the highest point in the vicinity to have them view the expanse. "The earth is very big; the part of the earth that you can see from this high point is but a very small part of the entire earth. What do you suppose is out beyond the farthest point we can see?"

3. If a child has gone on a fairly long trip, he might explain the trip to the children and tell of the things that took place. He might have gone to bed on the train, had several meals while traveling, and he might have seen mountains, oceans, rivers, plains, and prairies. This activity should serve to give the children some idea of how far the trip was. The distance traveled might be compared with the total distance around the earth. It takes a longer time to go around the earth.

Page 39. **The Earth Is Round.** Use the picture on page 39 for a discussion of round-the-world flights, that are being made constantly, and of world-girdling ocean trips. Roundness of the earth is, to many children, an entirely new concept. It might be emphasized that the globe is a true picture of the earth. "Notice that it is round like a ball." If it should happen that the children know of anyone who has gone around the world, they might question him. They might ask, "How long did it take? Did you know you were going around a big ball?"

If the school happens to be near an ocean, it is effective to take the children to the coast where they can watch a ship either coming toward them or receding from sight. In the former case the masts are seen first, and then the smokestacks, and finally the hull. In a receding ship the masts are the last to be seen. This activity can be demonstrated in the classroom, using a large globe and toy ships.

Pages 40-45. **The Earth Pulls.** Here the children are introduced to experiences associated with the gravity of the earth. It will be noted that *gravity* as a word is not used. At this level so much that happens in the lives of children in both work and play is based on the "pull" of the earth for its explanation that they should be acquainted with the fact that the earth does exert a pull. They pile blocks and the blocks fall, they tumble from their scooters, they slip on a trapeze, and they fall to the ground.

CONTENT

Gravity is the force that pulls all things toward the center of the earth. No one knows exactly what causes it; but it is known that all objects that have mass exert an attraction on all other objects. Gravity is useful to us every minute of our lives. Imagine the consequences if it should cease for a fraction of a second!

The plant and animal life of the earth is adapted to gravity. The roots of plants grow downward because of it, and the internal organs of the higher animals are so constructed that they are supported against the constant downward pull of it.

SCIENCE MEANINGS FOR THE CHILDREN

All things are pulled toward the center of the earth.
The pull of the earth holds buildings in position.
Things fall down.

PROCEDURE

The children may look at the pictures on pages 40 and 41 to see what objects are falling. Some of the children may suggest that they experiment to see what happens when they drop things. Let them drop their caps, pencils, erasers, pieces of paper, and the like, noticing that all of them fall to the floor or to the ground.

The fact of the constancy of gravity may be developed in connection with the statements about the school on page 43. The teacher may further emphasize this unvarying force of nature by asking, "Are there any things in the world that are not affected by the pull of the earth?" The children may suggest airplanes or balloons. It is true that aircraft seem to defy gravity, but as soon as the power of an airplane is shut off, the plane is pulled back to the earth; and as soon as the weight of a balloon is greater than that of an equal volume of air, it also is pulled to the earth. There is nothing that is not pulled toward the earth.

Before children read the last five lines on page 41 let them tell of occasions of falling while playing.

Use the humorous incident on page 43 to let children pattern stories of how funny it would be if other things they know went flying off into the sky and were not pulled back to the earth.

OTHER ACTIVITIES

1. The children might make paper darts and throw them into the air. The darts will float in the air briefly, but, like all other things on the earth, they will be pulled to the ground. When the dart is thrown with much force it will stay in the air longer than when it is thrown with less force.

2. A reading chart might be developed with some such title as "What Might Happen if the Earth Did Not Pull." Ideas sug-

gested in *Science through the Year* could be entered on this chart, such as the following:

Balls would go away from the earth.
Children would fall up.
The school would fly into the sky.
We could not stay on the earth.

Pages 46-47. The Earth Moves. That the earth moves is a new conception for most seven-year-olds. "If the earth is moving," they may ask, "why can't we feel it?"

The motion is not apparent because the earth does not pass near-by objects, as a train passes trees, telephone poles, rocks, and houses. Then, too, all the objects on the earth move with us and at the same rate of speed. There are no irregularities in the movement of the earth. It moves smoothly with no vibration and without any starting or stopping.

SCIENCE MEANINGS FOR THE CHILDREN

The earth moves.
The earth moves all the time.
The earth moves very fast.

PROCEDURE

It is not expected that children of this age level will acquire a complete understanding of the motions of the earth but only that they understand that it does move.

Turn a globe on its axis to illustrate the manner in which the earth rotates. The teacher may wish to have a child stand and then turn around in the manner in which he thinks the earth rotates.

The teacher may wish to use a globe and a bright light to develop the relationship between the rotation of the earth and the succession of day and night.

OTHER ACTIVITIES

Use this experiment while reading pages 46-47. To show the connection between rotation and the succession of day and night,

place a slide projector, or some other source of light, at a distance from a globe, aiming it so the light falls upon the globe. Put a piece of modeling clay on the globe and place in this a small flag or figure to represent the school. As the globe is rotated, the flag will be in the light (daytime) part of the time and out of the light (nighttime) the rest of the time. Such an activity will serve to give meaning to the motion of the earth.

EVALUATION

In this chapter on the earth the underlying purpose is to give the children a feeling for the vastness of the globe on which they live. Have the children grown in their understanding and appreciation of the smallness of their immediate surroundings? Do they now know that there is much more to the earth than that which is within their vision and their experience? Have they come closer to an understanding of the science meanings listed throughout this chapter of the Manual?

Children may desire to make a list of the learnings they have made. A list such as the one given below serves to clarify learnings, and also provides a dynamic reading experience since they have made it themselves.

The Earth

The earth is big.

The earth is round.

The farm is a small part of the earth.

The earth pulls things.

The earth moves.

It moves faster than airplanes.

Use the questions given on page 48 under "Do You Know?" and on page 49 under "Things to Think About" for evaluation purposes. The suggestions given there are intended to offer ideas for discussions, to provide for further activities, or to take care of individual differences in the group.

Do You Know? (p. 48). 1. Gravity pulls it back to the earth. 2. Gravity pulls you back to the ground. 3. The answers will vary. Some may be: buildings would go up; people would go up; air-planes would keep going up.

Things to Think About (p. 49). 1. The answers will vary. Look for many responses, such as birds, frogs, snakes, and trees. 2. Fields, mountains, rivers, oceans. 3. Gravity pulls them down. 4. Birds, insects, balloons, dirigibles. 5. The answers may vary, but the only correct answer is *no*, because anything that rises into the air does not leave the earth since the air is part of the earth. 6. The answers may vary. For correct answer see answer to question 5. 7. Yes. 8. Yes. 9. The answers will vary. 10. The answers may vary. A ship's masts and funnels are seen before its hull appears when it is coming toward you.

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FILMS

Our Earth*

Boats

Airplane Trip

*Films so designated are somewhat advanced in comparison with the text, but may be useful for some groups.

IV. ROCKS AND SOIL

Pages 51-57. **Rocks in the Park.** Children constantly bring rocks into the classroom and ask questions about them. The teacher may make the most of this spontaneity by providing a few shelves where the rocks may be kept. Keen interest in the various kinds of rocks and the story they tell of the earth's development can be aroused in children through a collection of rock specimens. Furthermore, the manner in which the breaking down of rocks formed the soil upon which we depend for all our food can be made the subject of much interest to children.

The way the soil is formed may be considered at various age levels. Small children may become acquainted with some of the simpler aspects of soil formation and, as they become more mature, they may learn the more complex aspects of it. In studying the soil with young children the teacher should avoid embarrassing those children who come from regions having poor soil. It must be remembered that wherever one may look, the soil will be different from that in other places.¹

CONTENT

The earth is composed of three different kinds, or states, of matter: liquids, solids, and gases. The solid part is composed of rocks with a covering of soil of various depths; and it makes up the greater part of the weight and volume of the earth. Knowledge of this solid part of the earth is very limited, since man has had no contact with it or information about it below a depth of ten miles.

The surface of the solid part of the earth in many places presents an appearance of sharp angles and rugged cliffs, owing to the action of the atmosphere, running water, ice, and wind. As a result of this action, there is a mantle of soil, finely broken-up rock, covering most of the level areas, below which there is coarser material called subsoil. Below this is solid rock.

¹For further reading on soil as a community resource see Gerald S. Craig, *Science in Childhood Education*, pp. 58-65. Bureau of Publications, Teachers College, New York City.

The rocks of the crust of the earth may be divided into three large groups according to the way in which they were formed: igneous, sedimentary, and metamorphic.¹

Igneous rocks are those which were formed from molten rock. They do not contain fossils, nor do they present a layered appearance. They are usually crystalline in structure, although there are some specimens in which the crystals are either very small or entirely absent. Some examples of igneous rocks are basalt, obsidian, granite.

Sedimentary rocks are made of sediments that have been pressed together. The sediments may be deposited by wind, water, or ice; or they may be organic deposits or chemically deposited materials. Rivers are constantly carrying mud, sand, and clay, and dropping them wherever the flow slows down. During the course of many centuries this deposit builds up to one of great size and weight. In the course of many more centuries, the materials are pressed together by the weight of additional materials above and consolidated into rock. This is called sedimentary rock. All sedimentary rocks, and metamorphic too, are made of materials that were originally contained in igneous rock. When the fire-formed rock was broken up, the materials became a part of some other form of rock.

Shale and sandstone are the two most common sedimentary rocks. Limestone, which is made by the chemical depositing of calcium carbonate or by the depositing of the shells of marine animals, is the third most common. Other forms of sedimentary rocks are coal, certain iron ores, salt, gypsum, chalk.

Sedimentary rocks are used extensively in the study of the past, for they may contain such things as fossils, mud cracks, wave marks, rain-drop impressions, and strata of varying materials.

Metamorphic rocks were formed by the compressive forces that have changed the surface of the earth, together with heat. The folding, bending, crushing, and crumbling of the surface of the earth sometimes changed the structure of igneous and sedimen-

¹For further material on rocks see *Science for the Elementary-School Teacher*, pp. 85-91.

tary rocks so greatly that entirely new kinds of rock have been formed. Some of the important metamorphic rocks are gneiss (pronounced nīs), schist (pronounced shĭst), quartzite, and marble.

An excellent illustration of the making of metamorphic rocks is had in the formation of anthracite, or hard coal. First peat is formed from the woody tissues of plants. Later the peat is changed to lignite, and still later to bituminous coal. If sufficient pressure and heat are applied to bituminous coal, the much harder anthracite results. If the process goes on still farther, the resulting product is graphite.

Soil is made from the weathering of rocks. It is a continuous process; new soil is always being made. Without soil life would be impossible. Therefore we should be concerned with keeping it in place. Soil may be made of clay or sand or decayed organic material or of a combination of all three. Clay soil is made of very fine particles, whereas sandy soil is composed of larger particles. Decayed organic material is called humus, and it is an essential factor of fertility.

SCIENCE MEANINGS FOR CHILDREN

There are both large and small rocks.

Some rocks are rough and others are smooth.

Some rocks are hard, while others are soft.

Soil is made from broken-up rocks.

Soil is not the same as dirt.

Good soil contains humus.

Rocks are useful to man.

There are different kinds of soil.

Plants grow well in some soils, but poorly in others.

PROCEDURE

The teacher may wish to begin this study by having the class study the pictures on pages 50-57. These will very likely cause the children to raise questions, to make suggestions as to what they should do to learn more about rocks, and to remember places where they have seen smooth and rough rocks, good and poor soil.

Of the four types of activity—reading, excursion, discussion, and experimenting—the children will doubtless choose to go on a trip to observe those things they have seen in the pictures. The teacher may suggest that they read part of the chapter first so they will know better for what they are looking. For example, on pages 51-52 the children will read about large and small, rough and smooth, hard and soft rocks. A short field trip will give the children opportunities to see rocks in these various forms and with these various characteristics. In most cases only a brief trip will be required to accomplish the purposes of the group, namely, to see large and small, hard and soft, rough and smooth rocks.

The trip might well be followed by a discussion of the things observed. Quite often some of the children will have seen much more than others. Such a discussion might well serve to suggest to the less observant child some of the possibilities that he missed.

As the children did on page 54, it is advisable to have the pupils rub two rocks together to see that dust is made thereby. The rubbing together of rocks goes on continually in nature. As a result of the action of wind, water, ice, and animals, one rock is made to move against another. Each rock thus subjected to friction is minutely reduced in size, the minute portion of rock worn off forming dust. It has taken a long, long time to make soil from rocks. We must save the soil we now have.

The teacher might find it necessary to clear up the meanings of *soil* and *dirt*. Soil is a valuable natural resource; it is vital and good; without it there could be no life. Dirt connotes filth, material that is undesirable. The word *dirt* should not be used synonymously with *soil*.

Try to plan a trip to a stream, or to the bed of a stream, which abounds with rounded rocks. A pail of water might be emptied with some force on a bank containing rocks and soil to show that the water carries rocks along and causes them to rub against each other in much the same way that the children rubbed them together and removed the rough edges.

The section on page 57 about the uses of rocks can be used to develop the concept of interdependence, that even though rocks may not be entirely desirable from the viewpoint of the farmer,

they are of inestimable value to the builder. Man uses rocks in the outer structure of buildings; he uses them in the building of fireplaces, in the making of cement, in the making of stone walls and house foundations, in road building and the like.

OTHER ACTIVITIES

1. The children may collect samples of conglomerate rock, or pudding stone, as it is sometimes called, consisting of sand and pebbles of various sizes pressed together into a solid mass of stone. (The teacher might bring out that conglomerate rock is a form of sedimentary rock, which was deposited chiefly by the action of water and hardened into a solid mass by subsequent pressure of superimposed materials.)

2. In addition to wearing down rocks by rubbing them together, they may be broken by pounding with a hammer. The children will very likely gain through this activity some idea of the great forces that are required to break rock. To avoid the possibility of flying rock splinters, it might be well to place the rock in a burlap bag before pounding it.

3. The children may wish to make collections of colored rocks, and to see how many different colors can be found. There is endless variety in nature.

Pages 58-60. Soil on the Farm. Soil is perhaps the most valuable of all the resources a country may have. All people should take an active part in preserving the soil, in improving it, and in making it more usable. The responsibility for developing an appreciation of soil rests largely on the elementary school, for this is the school that the mass of the people attend, and it is imperative that the masses know the importance of soil and have a high regard for it.

CONTENT

The weathering of rocks, which is a continuous process, results in the formation of soil. When sandstone is the beginning rock, sandy soil is the result. Usually sandy soil is poor for the growth of plants, since it contains only a few chemical elements. How-

ever, the fertility of this type of soil may be increased by the addition of organic materials.

Clay soil, on the other hand, is more fertile, because it is made from igneous rock, which usually contains more chemical elements. It also is made of smaller particles, which enable it to hold more water and thus to slow down evaporation. Many plants do not grow well in clay soil, however, for when it is dry the soil becomes hard and baked.

The best type of soil for agricultural purposes is loam, which is a mixture of sand and clay. If there is more sand than clay in the mixture, it is called sandy loam; and if there is more clay than sand, it is called clay loam. Sandy loam is easier to prepare for planting and easier to work after the seedlings have developed.

SCIENCE MEANINGS FOR CHILDREN

There are different kinds of soil.

There are soils of different colors.

There are soils with rocks in them.

There are soils without rocks in them.

People need soil to grow food.

Plants grow well in some soil, poorly in others.

PROCEDURE

Use the plan in the story on page 58 when children are going to plant something at school. Before reading page 58 discuss the different kinds of soil in the picture. What kind of soil do we need? During the year there will be numerous occasions when the soil may be studied. When the class is planting seeds in indoor boxes or pots or when they are potting plants is a good time for the teacher to develop the meanings listed above. In addition to bringing in various kinds of soil from areas about the school, the children will want to go out to see the soils and the places from which they come. A field trip might be built around the objective of finding places where there are black, red, yellow, and white soils. It may be that not all these kinds will be apparent around the school; but it is advisable to go as far

as possible with this plan and to get as many different kinds as can be found.

On page 60 of the book the children filled their flower boxes with soil from the woods. This would probably be the richest soil, since it would contain a great deal of decayed leaves, twigs, and other organic materials.

OTHER ACTIVITIES

1. The children may bring in samples of various kinds of soil. This may be a group activity; or the children may be encouraged to make individual observations and to bring in as many kinds as they can find. The samples may be placed on sheets of paper and in such a place that the children may look at them closely. A reading glass should be provided so they may see the variations in the size of the particles. Clay soil is made of fine particles; sandy soil, of coarser ones. Loam is a mixture of the two and decayed organic material. The teacher should emphasize again the forces that must have been exerted to reduce rocks to such fine particles.

2. The children may wish to make a list of those forces which they believe break up the rocks. The list might include such items as these:

Water rolls rocks along.

Water rubs rocks together.

Wind blows sand against rocks.

3. The children might secure a very smooth rock and a slightly roughened one. Sandpaper the rough rock vigorously. Can it be made as smooth as the one that was smoothed by natural forces?

Pages 61-62. An Experiment with Soil. Try the experiment on pages 61-62. Have the children compare their collection of soils with that in the picture on page 61. Ask them, "What does your experiment tell you about what plants need?" Permit the children to check their experiment by reading page 62. The experi-

ment with soil provides a situation in which the children may develop an appreciation of the relative values of the various soils around their school and on their farms. In setting up the experiment, identical containers should be used for each type of soil, the seeds should be planted at the same depth in each container, the pots should be located in the same place in the room so they will get even amounts of light, and they should be watered with equal amounts of water.

The teacher may wish to use radish or bean seeds, since both of these grow rather rapidly. As growth becomes apparent, and as it progresses, records might be kept of the changes that take place. A large record card might be used for each jar. Information such as the following might be entered:

1. Began to grow on November 5.
2. The bean plant grew fast.
3. Died on November 12.

The teacher will find it effective to have the children draw conclusions about the relative merits of the various soils used in the experiment. They may find (1) that sandy soil dries out rapidly, (2) that clay soil packs rather tightly, (3) that loam grows things well, (4) that plants do not grow well if the soil is too rocky.

Page 63. Something to Think About. This page is planned to provide the teacher with material that will serve to place before the children viewpoints that every American should have firmly imbedded in his mind; namely, that soil is useful to our country, that it is clean and is not dirt, that one should take care of the soil and should constantly strive to make it better. The teacher might well use this material to start a discussion of the various methods that the fathers of the children are using to save and improve the soil on their farms. Erosion-control methods might be discussed, fertilizing methods, cultivation, rotation of crops, and so on. Any discussion of these methods would naturally depend upon the readiness of children, interest, and language development.

EVALUATION

Concepts such as the great age of the earth, the tremendous time required to build soil, the great forces at work breaking up the rocks, are often difficult for children to attain in even a small degree. In their casual conversations adults use familiar phrases to denote ideas of great age and extraordinary power. They may say that something is "as old as Methuselah" or "as powerful as a tractor." In much the same manner children reflect their growth through talking and discussing with their friends and classmates. The teacher might listen to their conversations, for by so doing she might learn whether they have misconceptions, whether they have some idea of time and of natural forces. Many a seven-year-old feels that his grandfather is very old, that there is nothing quite so old as he. If through listening to conversations and through discussion the teacher can determine that the child's conception of age has broadened, the teacher may well feel a sense of satisfaction. The children may wish to write a story to tell what they have found out about rocks and soil.

*Some rocks are very large. Some rocks are very small.
Soil is made from rocks. Etc.*

A chart labeled "These Things Are Old" might have pictures of trees, rocks, and oceans. Another labeled "These Things Are Young" might have pictures of children, airplanes, and the like.¹

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¹For further information about the age of the earth see *Science for the Elementary-School Teacher*, Chap. VII.

*Films so designated are somewhat advanced in comparison with the text, but may be useful for some groups.

V. THE SUN

On pages 32-49 the idea of the tremendous size of the earth and of the smallness of the child's immediate environment was developed. Although the earth is large, the sun is many, many times larger. It should be borne in mind throughout the study of this chapter that children are able to secure relatively few correct ideas about the universe from their own reasoning and observation. The child looks about him and sees what seems to be a large earth. The sun and stars look small by comparison. They look smaller than the trees, houses, and buildings; certainly much smaller than lofty mountains. The child may think that the sun moves around the earth, that the sky is a dome with holes in it through which stars shine, both of which are quite natural conclusions. See discussion and misconceptions on page 17 of this Manual. It is imperative that the child be given reliable information. For the subject matter of this chapter, as for many other phases of science study, one must rely on the information supplied by authorities. Here the information of astronomers should be made available to children.¹

Pages 64-65. *The Morning Sun*. Children will already be aware of the unfailing regularity of the sun, and they will be familiar with the saying "The sun rises and sets." Because of ancient misconception and modern faulty vocabulary this statement has come into general use. Actually the sun does not move from the east to the west as it appears to do. The revolution of the earth from west to east makes the sun *appear* to rise and set.

CONTENT

The earth revolves on its axis from west to east. This causes the illusion of the westward-moving sun. Although to the earthly observer the sun looks small, we know that it is huge; in fact, about a million earths could be contained in the sun. The sun is about 93,000,000 miles away, and it is approximately 864,000 miles in diameter.

¹For further information about the sun see *Science for the Elementary-School Teacher*, Chap. IV.

SCIENCE MEANINGS FOR CHILDREN

The sun comes up every day.
The sun comes up in the east.
The sun goes down in the west.

PROCEDURE

Use the picture on pages 64-65 to identify familiar places on Joe's farm, such as the trees, barn, and house. Have the children note the position of the sun. Ask, "Where do you see the sun in the sky early in the morning at your house? Does it look small or large to you in comparison with buildings and trees? Does it look like a red ball in the morning to you? What did the sun look like to Joe?" Now have the pupils read page 65 to find out.

This study may well begin when children are observing signs of the coming of winter, such as falling leaves and the days becoming shorter. It is important to develop the idea that the sun "rises" and always in the same relative part of the sky. It might be well to develop an understanding of direction now by introducing the thoughts "The sun comes up in the east" and "The sun goes down in the west." Children will, quite normally, believe that the sun is smaller than the earth. Some of the activities below may be helpful to the teacher in showing why this idea is an illusion.

OTHER ACTIVITIES

Try activities 1, 2, and 3 to give the children more experiences from which to generalize about the sun as they see it.

1. The coming up and going down of the sun may be shown by using a large globe and a flashlight or other source of light. Shine the light on the globe and, after having placed a piece of modeling clay on the globe to represent the school, slowly rotate the globe to show how the earth moves into the sunlight (representing morning) and how it slowly moves out of the sunlight (representing evening).

2. The sun looks small to Joe, but actually it is very large. A child might hold a piece of chalk close to the other children and

gradually move away from them. Does the chalk look smaller than it did when viewed close up? Does it really become smaller? This activity might be more effective if done outside where a greater variation in distance might be obtained. Could the sun provide us with so much heat and light if it were as small as it appears to be?

3. In developing the idea of direction, the teacher may wish to inform the children that when they face the morning sun they are facing the east, and the west is behind them. If they will raise their arms horizontally, the left arm will point to the north and the right arm to the south. When they look at the late afternoon sun they are facing the west, and the east is behind them. If their arms are now raised horizontally, the right arm will point to the north and the left arm to the south.

Page 66. The Sun Is Large. Since the teacher has already given the children some idea of the size of the earth by recalling pages 34-38, she has something upon which to build. She might wish to begin this study by having the children express their ideas about the size of the earth (thus providing for use of learnings). They will be impressed with its great size. The teacher may note misconceptions. They are now ready to take the next step; namely, to learn that the sun is many, many times larger than the earth. The children should not be expected to obtain a full understanding of these sizes, for it is rare to find mature persons who fully appreciate them.

PROCEDURE

The teacher may wish to discuss the size of the earth and of the sun. *Large*, a new word, might be written on the board in its context—"The sun is large." During the discussion the teacher may wish to use some of the activities suggested below to develop ideas and to give tangible material for further discussion.

OTHER ACTIVITIES

1. See activity 2, page 66 of this Manual.

2. The teacher might draw an arc of a circle in the corner of the blackboard to represent the sun. It should be a large arc—so large that if the circle were completed, it would more than fill the largest classroom. At the other end of the blackboard she might draw a small circle (about an inch in diameter) to represent the earth. "The sun is much larger than the earth; it is larger than many earths put together."

3. This might be a good place to build a science reading chart, using the title "The Sun Is Very Large." Ideas for what to include may be obtained from page 66 of the text, the picture on pages 66-67, as well as from the children's own experiences.

Pages 67-69. The Sun Is Hot. It is doubtful if any man has an appreciation of the great heat of the sun; so do not expect children to gain a deep understanding of it. However, the teacher may develop the ideas that the sun is very hot, hotter than anything on the earth, that it heats the earth and supplies it with light, and that it heats and lights the moon. Through the presentation of accurate information many fallacies about the sun may be corrected, such as the belief that the sun is a mass of burning gases.

CONTENT

The earth receives heat and light from the sun because of the tremendous amount of energy released in the sun by the breaking up of the atoms of which it is composed. Nothing can replace the sun. Even in winter we receive heat from it; if we did not, the temperature would fall so low that no life could exist. The warmest hours of the day occur when the sun is highest in the sky; and the warmest seasons occur when its rays are most direct.

PROCEDURE

Use the pictures on pages 67-69 to introduce the idea of the sun's heat. The new words as listed on page 223 of the text should be written on the board and their meanings developed by means of discussion and explanation. The words should not be written alone, but should be shown in the context of the book.

OTHER ACTIVITIES

1. Before reading page 67 the children might tell of occasions when they became conscious of the great heat of the sun, such as when they suffered a severe sunburn or observed the wilting of plants in the garden.

2. Use experiments to help children to gain some idea of the intensity of the sun's heat. A biconvex lens (magnifying glass) might be used to set fire to a piece of paper to show that the heat of the sun is so great that objects can be made to burn when properly exposed to it.

3. Various metal objects might be placed so that some of them are in sunlight and some in shade. Those in the sunlight will feel much warmer to the touch than those in the shade.

4. The sun is composed of incandescent (glowing) gases. Children may need some discussion to determine just what a gas is. The air is made of gases; gas is burned in a stove. The wires, or filaments, in an electric bulb are glowing, or incandescent; they do not burn. In much the same manner the gases of the sun are glowing; they are not burning, for if they were they would have been burned out long ago. The sun is much older than the earth; it existed long before the earth formed.

5. To show that green plants need the light of the sun, two similar plants may be so placed that one is in sunlight and the other in darkness. The plant in the sunlight will grow well, whereas the one in darkness will be stunted or may die.

6. After reading page 69 the children may wish to make a reading chart somewhat like the following:

*Why We Need the Sun**The sun gives us light.**The sun gives us heat.**Light and heat make plants grow.**We eat the plants.**We need the sun for our food.*

Pages 70-72. **The Sun Shines All the Time.** Before reading pages 70-72 use the pictures, noting the sunshine above the clouds and rain. Because of expressions used by many adults, children often arrive at the erroneous conclusion that if a day is cloudy, the sun is not shining. Adults will say, "The sun is not shining today." Children interpret this literally, and thus build up a misconception. As the picture spread on these pages shows, the sun is shining even though it may be cloudy. High-flying planes always fly in clear, sunny skies, for they are above the clouds that blot out the sun.

Joe's statement on page 72, "The sun is not shining at night," is an idea commonly held by children. Do your children agree or disagree with Joe? In handling the statement full recognition of thinking must be made, however. Keep in mind that mankind required centuries of study to determine that the universe is as we know it to be today. In view of his immaturity Joe's remark is therefore a perfectly natural one. See discussion and children's misconceptions on page 17 of this Manual.

PROCEDURE

The teacher may wish to discuss what happens to the sun when it goes down or where the sun is when it is cloudy. During the discussion new words will arise. The teacher should acquaint herself with the new words that will be met in the reading (see page 223) and be ready to write these on the board in sentences somewhat as they appear in the book. This will give children confidence when they read them.

OTHER ACTIVITIES

1. The fact that the sun is shining somewhere all the time may be shown by using a flashlight (or other source of light) and a globe. Shine the light on the globe and slowly turn the globe in a counterclockwise direction. While one part of the earth is turning into the sunlight, another part is turning out of it. One half of the earth is always lighted. Encourage children to question the accuracy of demonstrations. Is the flashlight large enough to

represent the sun's size in relation to the size of the earth? How large should it be? It should be as large as the school or several schools combined. If it were so large, it would have to be very far away.

2. The teacher may wish to have the children make a large chart on which to paste pictures of people on the other side of the earth. It might be labeled as follows: "These People Are Asleep When We Are Awake" or "These People Are Having Night When We Are Having Day."

3. After the children have discussed the pictures and read pages 64-72, they might plan to paint large murals to show

a. The size of the sun in proportion to near-by objects, such as the school, trees, and houses.

b. The color of the sun.

c. The directions of the "rising" and the "setting" sun.

Pages 73-74. Shadows in the Sunshine. The purpose of this section is to make children aware of the fact that there are shadows when the sun is shining and that the length of the shadow is related to the position of the sun in the sky. The pictures illustrating the antics of Joe and Jane are suggestive of some of the things children might do to see how varied their shadows may be made to appear. Provide time for the children to experiment with the ideas given on pages 73-74.

ACTIVITIES

1. The study of shadows might begin with observations of the shadows of trees, buildings, and other objects. When the children first arrive at school, the teacher might have a large sheet of wrapping paper or sheets of newspaper pasted together. Have a child stand so that his shadow falls on the paper. Trace around the shadow and then cut it out. The shadow will be long, and the paper representing it will likewise be long. At noontime the same activity might take place, and again near the close of the school day. The papers representing the shadows will be of different lengths. The longest shadow was made when the sun was

lowest in the sky, the shortest when it was highest. The shadow made in the afternoon fell in the opposite direction from the shadow made in the morning. In carrying out this activity it is necessary that the same child be used and that he stand in the same place each time.

2. The activity above may be carried further by making fall and spring shadows. The low sun of winter makes a long shadow, while the higher sun of late spring makes a shorter shadow. Long shadows may be connected with coolness, while short ones may be related to warmth.

Page 75. An Experiment with Shadows. This experiment provides an interesting activity that can be carried on in the classroom. The experiment might be altered, if facilities permit, by suspending a sheet so a child may be placed between it and a source of light. The making of shadow pictures is fun and serves to develop ideas such as those mentioned above. The teacher and pupils will think of many ways in which the activity may be modified, such as making a guessing game of it: "Who is this? What is he doing?"

EVALUATION

When the reading, discussing, and experimenting are completed, it is not at all necessary to check to see if each child can answer a static listing of questions. Some may be able to do this with great accuracy and yet have little, if any, appreciation of the ideas they have been studying. If the teacher wishes, she may have a discussion period in which the children are asked to explain certain ideas; for example, "Can you tell us how we know the sun is shining all the time?" The child might demonstrate with a flashlight and globe the idea of day and night. Other questions might be the following: (1) Why does it become cooler in the evening? Can you show us by using the globe? (2) How do we know that plants need heat and light of the sun? (3) Why do we think that the sun is very hot?

But it is more important that the child have some appreciation of the great heat and size of the sun, of its importance to us, of

the "rising" and "setting" of it, than that he be able to answer such questions as those given above. It is often good practice to keep the idea of evaluation in mind throughout the teaching, and for the teacher to be appraising her own work as well as the work of her pupils. "Am I just pouring out facts, or will this activity make the idea meaningful?" "Is this an effective way of developing the idea, or is there a better one?"

Misconceptions will be made apparent. The teacher should treat them with consideration and strive to give the child the truth to the extent that his maturity enables him to understand it.

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VI. IN THE WINTER

This chapter, "In the Winter," is longer than previous ones, for there will not be as much opportunity to explore out of doors when the weather is cold and wintry. Moreover, the children will have developed greater ease of reading and will therefore be able to cover the additional text material. It is suggested, however, that excursions be made as much as the weather may permit. Throughout this chapter the content may be associated with children's spontaneous interest. In the absence of such interest it is possible to develop it when children have association and experience with the phenomena of their environment.

Pages 77-80. A Walk in the Winter. Jane's question "Will we see any animals today?" is a natural one. It may be that children in your group will ask the same question or similar ones. The best way to satisfy the curiosity of children is to take them into the fields and down to the brook so that their questions may be answered at first hand.

To withstand the rigors of winter animals must be adapted to the cold. The teacher should keep in mind the big ideas: (1) animals are adapted to life in their surroundings; (2) animals must struggle to obtain food.

PROCEDURE

Compare the pictures on pages 76-80 with those used in the chapter "In the Autumn" on pages 16-31. If the children have selected a particular place to watch for seasonal changes, now is the time to plan for a winter trip. Read pages 77-80. Do these suggest signs of winter for the children to look for? Are there other signs in their region?

Use the pictures on pages 76-80 before going out, to give the children some idea of the things for which they may look. They might see deer and rabbit tracks and other signs of the presence of animals. Are there fish in the pond now? Where are the turtles? Are there any animals in the ground under the snow? How do animals get along in the winter?

OTHER ACTIVITIES

As discussions and reading develop, try these activities:

1. It may be possible to keep turtles, salamanders, or tadpoles in the classroom during the winter. Although they will not actually hibernate indoors, the children will see that they slow down and are less active than in spring and summer.

2. Try to identify animal tracks found in the snow. Do the tracks give a clue as to what the animal was doing? It might have been getting food, building a shelter, or getting water from the brook.

3. It may be desirable to paint a large mural displaying a cross section of the ground, showing turtles, woodchucks, and frogs hibernating in their underground homes. Deer, rabbits, and foxes that live above the ground might also be shown.

Pages 81-83. Winter Birds. Some birds stay with us all the year, and others come from the Far North to spend the winter where it is comparatively warmer. Throughout the study of animals and their adaptations the teacher must guard against the impression that they think and plan for the coming of winter, as men do.

PROCEDURE

As suggested in the book, a field trip is advisable, to see the birds in their habitat and to learn what they are doing. The reading may precede the excursion, although it is felt that reading will have more purpose and meaning after children have experienced those things about which they are to read. It is also believed that they will have a better knowledge of the words if these are first met through the discussions that precede and follow the field trip. The teacher might ask the class, "Do we see as many birds now as we did in the autumn? What has happened to them? What do those that stay here eat?" The children will probably suggest that they take a walk to see.¹

¹For information about birds see *Science for the Elementary-School Teacher*, pp. 360-364.

OTHER ACTIVITIES

1. Observe the rather drab appearance of the winter birds. See that they are eating seeds and that they fluff their feathers to keep warm.

2. Build a feeding station. Find a place for it where it can be seen from the classroom, and keep it supplied with suet, grain, and dried bread. Birds often have a difficult time to find enough to eat. We should do whatever we can to care for them. Do certain birds prefer certain foods? Do some birds frighten away the others and then eat the food?

Pages 84-89. Animals at the Pond. Life does not cease with the coming of winter. Although there are few signs of life about the pond, the insects, turtles, snakes, and frogs that were seen there in the fall are still about, although most of them are not active. On page 86 Joe jokingly suggests that the snake might have flown away. Such an idea may be a serious one to some children, for to many this will be their first introduction to the way in which animals become inactive with the coming of winter. The teacher will, by careful observation and by listening to conversations, uncover misconceptions and plan her work so as to correct them.

The children may wish to make a list of what the animals at the pond are doing. The list might include the following: (1) The snake is resting; (2) The frog is resting; (3) The turtle is resting; (4) Many insects have built cocoons and are resting; (5) The fish swim slowly under the ice.

The teacher has a good opportunity here to have the children do some reasoning. What could have happened to all the animals that were here in the fall? Could they fly away? Could they walk or swim to a warmer place? Did they all die? What is there for them to eat?

Pages 90-91. Animals on the Farm. The material on these pages is within the experience of many children. If they do not have horses, perhaps they have cows and can explain how they are different in winter. All animals are adapted for living in the place where they are naturally found.

ACTIVITIES

1. Make a trip to a local farm to see how the horses look in winter. While there, see how the farmer has made it comfortable for the animals by providing a warm barn and by storing food.

2. The children might take pictures of their pet horses now so they may compare them with pictures that they will take later in the spring or summer. Animals look different during the various seasons.

Pages 92-95. Some Plants Live All Winter. A few plants in the classroom will add to the interest in the study of plants out of doors. Various bulbs can be planted in window boxes, seeds of all kinds can be planted in boxes, and small deciduous trees of two or three years' growth can also be brought into the classroom for observation. It is well to emphasize that the needles on pine trees are really the leaves of the tree.

PROCEDURE

The study might well begin with a discussion about plants in the winter. The teacher might ask, "Does your mother do anything about her flower garden in the autumn? Does she cover it with leaves? Does she leave tulip bulbs in the ground? If the bulbs are dug, are they planted again in the spring? Do all the trees lose their leaves in the autumn?" The teacher should make an effort to use the new words that the children will meet in their reading. The new words in this section are *dead, roots, kill, freeze, glad, lose, buds, enough, pines*. It is effective if new words are written on the board so children may become acquainted with their appearance.

OTHER ACTIVITIES

1. Take a walk to see plants. Notice the grass. It appears to be dead; but it cannot be, for it grows when the weather becomes warm. The trees may appear to be dead; but on closer inspection buds can be seen on them. The buds will produce leaves in the spring. As suggested on page 95, children need to be told that

trees do not consciously send messages to the leaves telling them to drop off; but that it is a natural process, one of adaptation.

2. The children may wish to make a map of their trip. On this map they might locate places where there are green trees, where there are trees that have lost all their leaves, where there are trees that have lost some of their leaves. They might label directions. They might wish to select a "favorite" tree that they are going to watch continually throughout the year.

Page 96. Some Plants Cannot Live in Winter. *Zinnias* is a new word and should be written on the board preceding reading so it will not be a stumbling block. The word *left* in such situations as "left and right" may be known to the children; but in the sense of staying behind it may be new and should be developed. Even though some plants do not live through the winter, the species, or family, in each case does not cease to exist, for the plant leaves seeds behind that will carry on the species.

ACTIVITIES

1. If possible, have the children observe seeds that have been made by plants. Do you think all the seeds will produce new plants? (Most plants produce many more seeds than necessary. Seeds will be eaten by animals, some will freeze, some will fall on rocks or barren soil; but a few will fall where conditions are favorable and will grow into new plants.)

2. Bring in various seeds. Plant some of the seeds in flower boxes and watch their development. Seeds may also be planted in wet sponges or on blotters that have been moistened so that germination may be watched more closely.

3. The children may wish to make lists under headings such as these: "These Plants Die in Winter," "These Plants Live All Winter." The former list would contain zinnias, petunias, asters; the latter would include trees, tulips, roses, and all kinds of shrubs.

Page 97. Think and Do. This page provides exercises that will help the teacher in appraising the attitudes developed in the children. It will be noticed that the activities and questions do not

imply that the authors expect the children to have acquired an encyclopedic knowledge of facts; but rather that they hope the children will have developed insights that will enable them to answer questions of how and why in nature.

This section may be used as an entire-class activity or it may be used to occupy those children who progress faster than the rest of the group. It is hoped, however, that the suggestions will not become mere busy-work assignments.

The answers to the questions might be as follows: (1) *a.* An untimely frost prevents seeds from developing, and it freezes the water in the plant. *b.* Food is hard to find, there is not much sunlight, it is cold. (2) Answers will vary. (3) Answers will vary but may include elm, oak, hickory, maple, apple, peach, and pear.

Pages 98-104. Winter in the City. People prepare for winter by getting in a supply of fuel, by seeing that the snowplows are in good condition, by getting a snow shovel. It may be especially important to explain winter conditions in the city if one's school happens to be located in the country or if the class happens to be composed of children who have not seen a large city.

Most of the animals in the city park do not hibernate in the sense that turtles and bears do. They rest a great deal, but emerge when it is warmer and when they are very hungry. Hibernation is not sleeping. It is much more deep than that, for when an animal hibernates its functions are so slow that it is barely alive.

ACTIVITIES

1. As new words are brought out in discussion, write them on the board to build an acquaintance with their structure. New words for those pages will be found in the Vocabulary List on page 223.

2. A walk to the park will be effective, for there the children can see the animals spoken of in the text. The children may wish to take peanuts with them so they can feed any chipmunks or squirrels that they may see. Some children who live near a park may want to take the responsibility of feeding the animals regularly and reporting to the class on the activities of the animals.

3. Even in the city bird-feeding trays may be put on the window ledge. If they are filled with grain and suet, birds will find them and will become regular visitors.

4. The children may make a list of what the animals in the park are now doing.

Page 105. What Animals Live Near You? Something to Think About. This page suggests activities that the children will enjoy carrying out. They like to test their knowledge. The teacher may use the ideas offered on this page only for those children who are faster readers than the rest of the group, or she may wish to use them to motivate general discussions. Many of the suggestions, such as those under "What Animals Live Near You?" might well develop into murals, lists, or charts.

The answers to the questions under "Something to Think About" might be as follows: (1) Birds go where it is warm; if they stayed where it is cold, they might die. (2) They can live on very little food, and food is hard to find. (3) Birds fluff their feathers, other animals ruffle their fur, still other animals roll themselves into a ball. (4) Fish stay alive by swimming under the ice. (5) The grass will grow again when the weather becomes warmer, because the roots remain alive through the winter.

EVALUATION

The teacher should have as her goals not so much the acquisition of facts as (1) the development of meanings, such as the effects of winter upon wild life; (2) the development of an appreciation of the relation of science to everyday living; (3) the development of a scientific attitude. Such developments depend on the acquisition of facts; but the facts are learned only because they are essential to the realization of these broad, over-all values.

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FILMS: Play in the Snow Frog Snapping Turtle

VII. AIR AND WATER

This chapter may be used at any time during the year. It is not necessarily dependent upon the preceding chapters. The teacher will find new science words listed on pages 222-223.

Pages 107-108. Air Is around Us. Even though air is an important part of their surroundings, children are often not aware of it because of its being invisible and intangible. Since it plays such a vital part in the process of living, and because of its importance in present-day transportation, the authors feel that even seven-year-olds should know something about it.

CONTENT

Air is everywhere; it is found in soil, water, plants, animals, rocks, and in all things apparently empty. Sometimes it is easier to grasp its universality if we think of the people of the earth as living at the bottom of a vast ocean of it, the ocean being anywhere from one hundred to five hundred miles deep.

SCIENCE MEANINGS FOR CHILDREN

Air is everywhere.

Air is over the city and the country.

Air is about the city and the clouds.

Air is in soil.

PROCEDURE

The teacher might begin the study of air¹ by asking the children if they know of anything that is all around them, something that they cannot see or take hold of and yet is so necessary that if they did not have it they could not live. This should lead to the recognition of air as a substance.

Before reading page 107 tell the children to look at the pictures on pages 107-108. Ask them, "What places do you see that show us where air is? Where would air be that Joe might know about? Alice?" There are no new science words on page 107.

¹For information about air see *Science for the Elementary-School Teacher*, Chap. IX.

The children may mention some of the ideas on page 107. Now let them read page 107 to see if there are places that have not been mentioned.

After reading page 107 the teacher might ask if anyone can suggest some way to show that there is air in soil, or in water, or that human beings cannot live without air. The children may suggest the experiment as given on page 108, or they may suggest some of the activities given below.

Look at the picture of Alice's experiment on page 108. Prepare a chart, if the children are interested in doing the experiment, with such items as

Is there air in soil?
We need dry soil in a jar.
Pour water into the jar of soil.
What shall we see?

Check the results of the children's experiment by reading page 108 to see what Alice found.

OTHER ACTIVITIES

1. That there is air in water can be shown by placing some water in a glass and allowing it to stand for a few minutes. Some of the air in the water will form in small bubbles along the inside of the glass.

2. The foregoing process may be speeded up by heating the water in the glass; however, it should not be boiled, for when it is boiling the bubbles are composed of steam and not air.

3. The children might hold their breath for a few instants to feel what happens when the body is deprived of a constant air supply. Air is necessary to life, and there is no place on the surface of the earth that does not have enough air to support life.

Pages 109-112. Air Pushes against Things. After reading page 109 see if the children wish to experiment as Alice did to prove that air pushes against things. Note the three new words on page 109: *against*, *pennies*, *hit*.

The experiment used to show the idea of air resistance demonstrates the need for careful analysis to prove a proposition. It will be noted that various means are employed for proving the proposition: two pennies are dropped, a penny and a paper, a penny and a paper ball, a paper ball and a big paper. The children may think that pages 109-112 have definitely established that air pushes against things; but the teacher should emphasize that just because an experiment works once, we are not justified in assuming that it will always work and that a proposition is true. To satisfy the needs of science a statement must be proved beyond question and must be true at all times under the same conditions before it can be accepted as true.

PROCEDURE

In this case it might be well to have the children read about the other experiments as done by Betty and Jack on pages 110-111. They might then select some members of the class to do them. While someone reads orally to give the directions, the experiments can be carried through. No doubt others in the class will want to do the experimenting. Allow them to do so. Check results by rereading if necessary.

SCIENCE MEANINGS FOR CHILDREN

Air pushes against things.

The air slows down the fall of the paper.

When the paper is made into a ball, it is smaller; hence there is not so much for the air to push on.

Page 113. The Parachute. Children will probably have heard the word *parachute* mentioned in connection with the armed forces; but they will not be familiar with the word, nor with the way a parachute operates. The teacher might write the word on the board to build an acquaintance with it. Read the first 7 lines of page 113. Let the children generalize from preceding experiments as to what might happen. Check their ideas by continuing to read page 113. Test this experiment to see if it works.

PROCEDURE

The children will want to discuss what they know about parachutes. Some of them may have had brothers or fathers in a parachute corps. They will want to tell about them. After the children have tried the experiment on page 113, the teacher might ask if they have ever seen the little parachutes that are the seeds of dandelions. She might ask: "Why are they shaped like parachutes? Do the leaves fall from the trees in the same way that Alice's parachute falls? Why not?"

Pages 114-116. Fire Needs Air. This section emphasizes the value that is had from a well-controlled experiment. The children will want to do this experiment over and over again. They should be allowed to do so. Much of our teaching is done too hurriedly and, as a consequence, many of the values that might be attained are lost. Sometimes the children will wonder whether the candle that was under the largest jar, and kept burning longest, would keep burning if it were put under the smallest jar. Do not answer the question, but rather suggest that they try it to find out. Whenever it is possible to learn something through an experience, that is the better way.

CONTENT

Fire needs air to burn. It uses the oxygen in the air. Actually some air will remain after a candle goes out, for candles will not burn when the oxygen in the air is less than 13 per cent. The oxygen content of the air is 20 per cent.

PROCEDURE

Look at the picture of the experiment on page 114. Can children make tentative suggestions as to what is occurring? They might read to the bottom of page 114 and plan material they would need for such an experiment. Note the repetition of the new science word *burned* (p. 114). Verify the results of the children's experiment by reading to find out what happened in the case of Miss White's group of children.

For safety purposes the teacher may prefer to handle the matches herself in this experiment.

The teacher should bring out the connection between the experiment and the control of fire in the home. Fires may be extinguished by smothering. If a person is on fire, he should be rolled in a blanket or a rug.

OTHER ACTIVITIES

1. The children might make a chart on "How to Put Out Fires." The chart might include such items as these: (1) Roll in a blanket; (2) Cover the fire with sand; (3) Cover it with soil. Seven-year-olds should be trained to get away from a fire rather than to try to put it out. They should also be taught that they should not run if their clothing ignites. This tendency to run is difficult to overcome; however, it is felt that the activity above will serve to make children think.

Pages 117-118. **The Air in the Balloon.** The fact that air becomes larger (expands) when it is heated is a new idea for young children and one that many of them will not have experienced. However, there are so many ideas in science, and it is such a vast subject, that growth of children would be sadly lacking if instruction were limited to only those things that children experience. Often experiences that are felt to be worth while must be introduced.

PROCEDURE

The children might read page 117 after they have been acquainted with the new words (see page 223). After reading about the experiment someone might be selected to do it. The balloon should have only a little air in it. After it is tied, it might be held over an electric hot plate, over a hot radiator, high over an alcohol lamp so the flame will not burn it, or over a stove, as suggested in the text. If the balloon is *filled* with air and then held over a flame, it should be fastened to a large stick so there will be no danger from the explosion.

The question Why did Betty's balloon go "bang"? should start a lively discussion. After a conclusion is arrived at, the teacher might ask the children: "How can you be sure that your answer is correct? Should you experiment to find out, or should you ask an authority, or should you find the correct answer by reading?"

Page 119. What Does the Air Do for Us? This page is designed to give emphasis to the fact that air is all around us. Discuss the picture on page 119. Whenever we build a fire, air is helping us. If air were not all about us, fires would not burn. Would this be good or bad? It will be obvious to the children that they will need a match to make the fire burn; it will not be so obvious that they need air, but the teacher can refer to the experiment with the jars and candles to help the children ascertain that air is necessary.

ACTIVITIES

1. Make a list of some of the things that air does for us. The list might include: (1) It makes picnic fires burn; (2) It makes the gas stove burn; (3) It makes the kitchen stove burn; (4) It makes the furnace fire burn; (5) It keeps parachutes from falling too fast.

2. The children may wish to go out and make a fire. This might be a good procedure, not only for the making of a fire but for developing the right procedures and respect for fire as well as for training in how to put out a fire safely.

Pages 120-121. From Water to Ice. Here begins a section that develops the concepts of the three forms of water: solid, liquid, and gas. It is not essential here that the children learn to use these words, but they should become aware that the three forms are all one and the same substance. They should become aware of the changes that water undergoes about them all the time. Children will have experienced sliding on ice on ponds or icy sidewalks and possibly slipping in crossing icy streets. Their experiences should be given expression before they read pages 120-121.

PROCEDURE

Look at the picture on pages 120-121. The teacher might begin with the question, "Can you walk on water?" Some will say yes; others will feel that you certainly cannot. The teacher might ask if there is any way in which they can find out. Some may suggest that they go down to the pond. (Be sure that the ice is thick enough for safety.)

OTHER ACTIVITIES

1. A pan of water might be placed on the window ledge on a cold day. The water will freeze. The pan of ice might be taken into the warmer room, and the ice will melt. Children may begin to get the idea that liquid water freezes when the temperature is low enough and that ice melts when the temperature is high enough.

2. A chart of how man uses ice might be made. The chart might include: (1) Ice is used for skating; (2) Ice is used to slide on; (3) Ice is used to save food; (4) Ice is used to keep ice cream frozen.

Pages 122-125. From Snow to Water. Many seven-year-olds do not realize that snow is another form of water. To them snow is snow, and water is water; they do not make the connection. If the activities of Joe and Jane are followed closely, the children will know that snow, water, and ice are different forms of the same substance.

CONTENT

Snow is frozen water vapor and is not frozen rain. When water evaporates from the earth, it either condenses into a liquid to make a water cloud, or it freezes into crystals (snow) to make a snow cloud. Frozen rain is called sleet.

PROCEDURE

If the children live in a region where ice and snow are uncommon, the teacher might use the pictures on pages 120 to 125 to

expand their knowledge of physical environment through pictures. Some children may have experienced such phenomena while traveling.

The teacher might have some children bring snow into the room. There might be several jars of it so all the class could see it melt and change into water. The jars of water might then be placed outside and, after a period of time, inspected to see if the water had changed into ice. If it had not, the teacher might have someone read the thermometer to learn if it was cold enough to freeze water. After doing the experiment above, and after introducing the new words as listed on page 223, the teacher might wish to have the children read the pages. They might read to learn if they did the same things that Joe and Jane did or to see if the way they did the experiment was better than the way Joe and Jane did it.

OTHER ACTIVITIES

1. The children may wish to make charts to show the changes of water. They might make one to show that water freezes to make ice. A jar of water might be shown at one end of the chart and a cake of ice at the other end. An arrow connecting the two might be labeled "Freezes." Another chart might be the reverse of this, and the arrow would be labeled "Melts."

2. In working with snow the children might be made aware of the crystalline structure of snow flakes and might note that no two are the same. There is endless variety in nature.

Pages 126-127. From Water to Steam. Here again children will have misconceptions due to the faulty expressions used by adults. People say, "See the steam coming out of the teakettle." They fail to realize or to state accurately that steam is invisible and that the white cloud forming at the spout of the teakettle is actually made of water droplets into which the steam has condensed. The children's misconception should be corrected. The words *invisible* and *condensing* should be replaced with words within the experience of children: *can't be seen* and *changing into water* might be better terms.

SCIENCE MEANINGS FOR CHILDREN

Ice is water.

Snow is water.

Steam is water.

PROCEDURE

Boil is a new word, and its meaning should be developed. It is sufficient with seven-year-olds to explain that a liquid boils when it gets very hot and that when water boils it changes to steam. *Steam* may be a new word to some. It is a gas that we cannot see and that is made when water boils. While the picture on page 126 shows the white cloud resulting from the condensation of steam, the experience is more meaningful when boiling is done in the classroom. Care must be taken, however, to assure that no accident can occur. Do not allow the children to crowd around the kettle; but rather allow the children to take turns putting their hands in the cloud.

OTHER ACTIVITIES

1. To see the changes that take place in water, the teacher may wish to use the same water throughout. The experience might begin with snow, the snow is melted, the melted snow is then frozen into ice, the ice is melted into water, and the water is then changed to steam. The same material may appear in various forms.

2. Charts such as the following might be made. A glass of water connected by an arrow to a boiling kettle, the arrow being labeled *Boils*. (Water is boiled to make steam.) A cloud to represent steam connected by an arrow to a glass of water, the arrow being labeled *Changes into*. (Steam changes into water.)

Page 128. Now Do You Know? Here are presented together the facts learned in the previous pages about the three forms of water. The answers to the questions might be as follows: (1) by melting it, or putting it where it is warm; (2) by freezing it, or putting it where it is very cold; (3) by boiling it, or heating it until it is very hot; (4) for drinking, washing, swimming, skating, boating, plant life, animal life.

Help children to generalize by studying the picture on page 128. Have them read page 128 to check ideas.

Page 129. What Do You Think? These questions may be used to begin a discussion; or the teacher may prefer to use them for those pupils who are better readers.

The answers might be: (1) because Joe was thinking of frozen water (ice), and we can walk on ice; (2) it is valuable for children to know that not all places are the same as where they live; the answers will vary.

Page 129. Try This Experiment. Perhaps if several of the children do this, the ice some of them are carrying will melt completely, while in other cases the melting will not be so thorough. The explanation might be that some of the jars were wrapped in many thicknesses of paper, insulating them against heat. The children might discuss why some melted while others did not.

Pages 130-133. Smoke in the Air. Children should be made aware of some of the problems that adults face. The problem of smoke is an important one in most cities. There is no need for man to breathe impure air, for there are methods for burning coal properly so no smoke is made, and there are methods for removing soot from chimneys. The pictures on these pages will serve to emphasize the need for doing something about making our cities better places in which to live. Although it is obvious that seven-year-olds can do little to correct the smoke nuisance, education begins with the very young, and it is only through education of the masses about the needs of man that correction will eventually come.

PROCEDURE

The children might be encouraged to look at chimneys on their way to school to see how many of them are smoking. They might ask their mother how often she has to dust. Some children may have visited in the country, and may therefore know how the amount of dust there compares with that in the city. They may

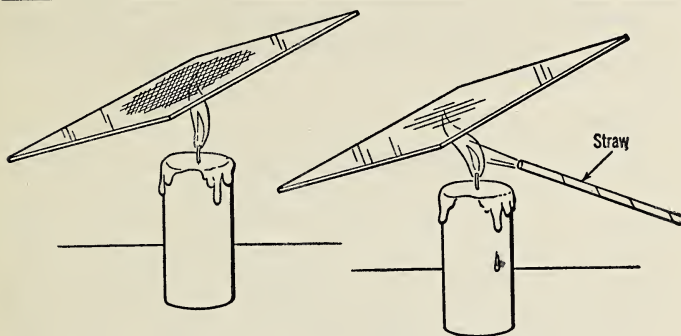


Fig. 5

wonder why some of the chimneys do not smoke. Many will want to find out, and can do so by asking their fathers or by asking the janitor of the school building.

OTHER ACTIVITIES

1. The teacher may wish to show the connection between smoke and a proper air supply. Light a candle and pass a glass plate (about 3" square) through the upper part of the flame. Does the black on the glass look like smoke? If the teacher now places a straw near the flame and blows air through it, little or no black will form on the plate. (See Fig. 5.) Fires produce less smoke when the air supply is adequate.

2. The children may wish to make a map on which they locate those chimneys that seem to smoke more than others. They might label their map "These Places Waste Coal"; for a smoky chimney usually indicates that not all the heat possible is being obtained from the coal, but that some is going up the chimney.

Pages 134-135. Smoke and White Clouds. Often children will declare dogmatically that the cloud issuing from a boiling kettle of water is smoke. The reading material explains that smoke is made only by materials that burn. When children understand

this statement, they are quick to see that the cloud could not be smoke, for water does not burn. When water is boiling, it is hot; but it is not burning.

PROCEDURE

As children discuss the picture on page 134, note misconceptions concerning cloud and smoke. It may be that during the teaching of previous ideas children will have called the cloud "smoke." The reading of this section will clear the difference between the two terms. After reading the section, the children should discuss it so the teacher may check for understanding. If it seems necessary, they should reread the pages. The teacher must not hurry learning. Certain ideas, such as the difference between a cloud and smoke, may require some time to be learned in a meaningful manner. Time used to insure full learning and the development of appreciations is well spent.

Pages 136-137. Where Does the Water Go? It is essential that the term *evaporate* be developed, for evaporation is the process by which all water enters into the atmosphere. The word will have meaning when the children perform the suggested demonstrations and note that the water disappears (evaporates).

Joe's experiment with the two jars develops the idea that water evaporates from an open container while it does not evaporate from one that is closed. It may be that drops of water will form on the inside of the cover. If it does, the teacher might ask, "How did the water get there?" The answer is that the water evaporated and then condensed on the cover.

In Jane's experiment the water will evaporate more rapidly from the pan. The amount of evaporation is directly related to the surface exposed to the air. Since there is a larger surface in the pan, evaporation from it will be more rapid.

PROCEDURE

After reading page 136 stop to discuss possibilities about the last two questions. Make plans to test these ideas by experimenting. Refer to the picture on page 136 if children need help in

listing materials. Children may complete their experiment and read to check their results with Jane's on page 137.

After reading page 137 the children might be encouraged to think of other cases where they have seen evaporation (the drying of clothes, the drying of the blackboard), and they might be encouraged to work out other ways of demonstrating the process.

EVALUATION

One method of evaluating is to determine whether children are able to apply their learnings to new and different situations. In the case of wind, for example, do they explain this in terms of the movement of air? Are they beginning to realize that even experiments are not always conclusive and that there may be other ways of establishing facts? Are they willing to change their ideas in the light of more accurate information? Do they accept ideas in a gullible manner, or are they anxious to read authoritative books to check findings?

It is apparent that the teacher cannot ascertain growth in these directions through a period set aside for that purpose. These are pupils' skills and attitudes that the teacher should have in mind throughout her teaching and which she should be able to recognize when she sees them in action. For example, a child may say, "That white cloud coming out of the kettle is smoke." Other children may deny this statement. Rather than engage in argument, one of the children may suggest that they read to find out which view is correct. The child who makes this suggestion has grown in scientific attitude; he has learned that it is better to get accurate information than to accept unfounded opinions.

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VIII. THE BLIZZARD

Pages 139-144. News from the Weather Bureau. Page 139 introduces for the first time the idea of other agencies and workers in a community. Let the children look at the picture on pages 138-139. Have them compare the seasons or changes that were occurring on pages 6-7, 14-15, 16-17, 33, 76-77, 78-79, 120-121. Before reading page 139 let the children mention means they have of getting news about changes in weather, such as newspapers and radios.

In the beginning of the year the idea that there are many kinds of weather was developed. The blizzard is introduced here because it is a rather common occurrence in some parts of North America and because it is an excellent illustration of change. The only constant thing about the world is its continuous succession of changes.

Children should be made aware that there are agencies, such as the Weather Bureau, that inform the people and provide them with facts that enable them to act more intelligently.

CONTENT

A blizzard is a severe winter storm that is usually preceded by relatively warm air. The stillness of the air before the storm is broken by winds that build up to a great force and bring with them vast quantities of snow. The wind causes deep drifts that tie up communication, isolate families and towns, and generally disrupt man's activities.

SCIENCE MEANINGS FOR CHILDREN

A blizzard is a severe snowstorm.

The Weather Bureau gives information about weather changes.
Men exchange information.

Weather changes from day to day, and from hour to hour.

We need all kinds of weather.

Too much weather of any one kind may be harmful.

Weather is very uncertain.

PROCEDURE

It would be effective to use pages 138-140 when a storm is approaching your immediate area.¹ The teacher might suggest that the children observe what is happening outside to see how the storm develops. During the discussion that follows, the teacher should develop an acquaintance with the new words, as listed on page 224. The children might then read the section to see how the storm described in the book is like the storm they are experiencing.

When the children have read through page 140, stop and use the illustration on pages 140-141. Note cold air moving toward Hill Top School. Note the trees being moved by the force of the wind. Children may now discover directions, north, east, south, and west, from their own school. Ask them, "From which direction do snow, rain, or wind come toward your school?"

OTHER ACTIVITIES

1. If the children do not know directions, they might learn them now. One may orient himself by facing the morning sun, which is in the east. His back is then toward the west. If he stretches out his arms horizontally, his left hand will point to the north and his right hand to the south.

2. In connection with the subject of the Weather Bureau the teacher may wish to show on the globe that there are stations all over the country (she may select such locations as New York, Seattle, Juneau, San Francisco) that gather information about weather conditions and send it to Washington, D. C., where the information is studied. From this information the experts there can determine with an accuracy of better than 80 per cent what the weather will be like.

3. The children might make a list of ways in which the Weather Bureau helps people. The list might include the following: (1) It helps the farmer by telling him when to plant crops; (2) It helps

¹For further information about storms see *Science for the Elementary-School Teacher*, pp. 201-209.

aviators by telling them whether it is safe to fly; (3) It helps mariners by warning them of storms and fog.

Pages 145-147. Caring for the Farm Animals. The blizzard is a natural force that man must consider when building his home and barns and when planning and planting his farm. Children like to feel that they are needed. The help that Joe is giving his father is intended to stimulate this feeling.

SCIENCE MEANINGS FOR CHILDREN

The radio gives information as well as entertainment.
Animals must be protected from bad weather.

PROCEDURE

When the children read on pages 146-147 about Joe and how he was needed to help his father, they will feel that they may perhaps help their parents when there is a snowstorm. They might discuss the various things that they could do during the winter.

Pages 148-149. Watching the Weather. The pictures on these pages serve to illustrate that weather is constantly changing. After the blizzard there is unpleasant weather for a few days, followed by an interval of clear days.

Using the question on page 149, "What kinds of weather can you tell about?" the teacher may wish to prepare a chart based on such states of weather as clear days, hot days, cold days, snowy days, rainy days, and foggy days.

EVALUATION

Have the children grown in their understanding of the concept of change? Do they have some idea of why storms occur? Do they realize that the weather they experience originates in some other part of the earth?

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- HUMPHREYS, W. J. *Way of the Weather*. Cattell, 1942.
- LONGSTRETH, T. M. *Knowing the Weather*. Macmillan, 1943.
- WENSTROM, W. E. *Weather and the Ocean of Air*. Houghton, 1942.

IX. IN THE SPRING

Children have a very real interest in the study of living, dynamic things. They like the antics of a squirrel as it gathers nuts, the singing and scolding of birds. The teacher can utilize these interests in this study of the growing of plants and the awakening of animals.

Pages 151-153. If their past experiences with spring have been pleasant, children will ask, "Will spring come soon?" The question provides the teacher with an excellent departure for discussion and observation to determine why the question was asked and to see if there are any signs of spring's coming. Throughout this section the teacher will see that the ideas learned may be related to the previous section called "In the Autumn." We learned there that many animals and plants were getting ready for winter. We now see these same living things resuming active growth.

SCIENCE MEANINGS FOR CHILDREN

Spring follows winter.

Green is the color of spring.

Leaves grow from buds that formed in the autumn.

PROCEDURE

It may happen that some child will spontaneously ask the question about the coming of spring. The teacher may then initiate a discussion to see why children think spring is coming. She may ask, "Have you seen any signs of it? What signs have you seen? Do you think we could see them if we went for a walk?" The children will enjoy observing the spring flowers, the grass turning green, the leaves bursting from the buds. Once more the teacher can develop the idea of change: as the seasons change, living things change; there is nothing constant in the universe.

Let the children study the picture on pages 150-151 to compare conditions in the spring with those in autumn and winter

shown on pages 16-17 and 76. Now have them read to see what Mary thought about the change in seasons.

OTHER ACTIVITIES

The children may wish to make a chart on which they will list their learnings. The chart might be called "Spring Is Coming," and it might include such items as these: (1) Violets are blooming; (2) Woods and fields are getting greener; (3) Leaves are growing from the buds.

Pages 154-157. Birds Are Moving Again. Look at the pictures on pages 154-157. Discuss the action of the birds. Look at the pictures on pages 21-26. Recall the time when birds were preparing to move south.

The return of the birds is interesting to watch. Children need but little encouragement to be made aware of them. Further emphasis might here be given the idea of the unfailing succession of the seasons: the seasons come and go—always in the same order and always bringing the same phenomena—and there is constant change in living things corresponding to the change of seasons.

SCIENCE MEANINGS FOR CHILDREN

Birds return in the spring.

Birds build nests to raise families.

PROCEDURE

The study may begin with a discussion of learnings that the children acquired in the autumn when they were observing the migration of birds. The teacher might develop the fact that the birds return as the days become longer and the weather becomes warmer. The discussion and reading should be augmented by several trips into the field to observe what the birds are doing. The teacher might keep in mind that it is not necessary that she be able to tell what kind of bird this one or that one is. Children will certainly be curious to know; but the teacher might suggest that they look very carefully at the bird to remember his size, color, habits. When they get back to the classroom, the children

might look up the bird in a bird handbook. If it is preferred, the children might take the handbook into the field. The purpose of this study of birds is not, however, to be able to identify them but rather to become increasingly aware of the changes that are going on, to see the relationship between the movements of birds and the seasons.

OTHER ACTIVITIES

1. Make several trips into the fields, down to the brook, and into the woods. An original trip may be made to arouse an interest in the study of birds, and subsequent trips may be made to learn more about birds, to see how many different kinds there are, to see what they are eating, to see if a particular nest now contains eggs, to see if the eggs are hatched and if the mother is taking care of the young.

2. The children might wish to place a birdbath, or a pan of water, in some suitable location. Do the birds visit the water? Do they seem to drink it or only to wash in it?

3. The children may wish to build and erect birdhouses. Simple ones can be constructed by seven-year-olds and may serve to attract birds to the environs of the school.

Pages 158-162. Other Animals Are Waking Up. Children are happy to be able to enjoy the out-of-doors now that the winter is past. Spring is the season of awakening, as shown by the appearance of those animals that have been hibernating, such as frogs and turtles. Although the term sleeping is used with reference to hibernation, it is not too accurate. Actually hibernation is a time of much greater inactivity than is sleeping. It is a hazardous period in the life of an animal.

SCIENCE MEANINGS FOR CHILDREN

Moths emerge from cocoons.

The bat is an animal (mammal) that flies.

Heat causes animals to emerge.

Frogs and turtles are cold-blooded animals.

Birds are warm-blooded animals.

PROCEDURE

This study may begin with a field trip to see if the children can find other signs of spring. Preceding the trip the teacher might recall the study made in the autumn when the children learned that some animals hibernate while others migrate. Let us see if the animals that went to sleep in the fall are now awake. The children may quite naturally think that a noise or a movement will wake the animals (for that is the way *they* are awakened); but hibernation is so deep a sleep that only increased warmth will bring about the change. Probably not all the things spoken of in the book will be seen on a single trip. The teacher might introduce the new words as listed on page 224 and then go ahead with the reading.

OTHER ACTIVITIES

1. If the children find a cocoon that still contains the pupa, they might bring it into the classroom in the hope of seeing the moth emerge. The cocoon may now be brought in, for the moth may be released into the out-of-doors when it comes out. The cocoon should be carefully suspended so that the moth can spread its wings.

2. So many things happen in the spring and the changes are so rapid that it is suggested that trips be made frequently. For example, even though no signs of frogs are apparent today, there may be many signs of them tomorrow.

3. It may be desired that additional items of information be added to the list under the heading "Spring Is Coming." Such items might be: (1) Frogs are waking up; (2) Turtles are waking up; (3) Bats are flying again; (4) Moths are coming out of cocoons.

Pages 163-164. New Plants and Animals. Young children are interested in young animals, in babies; they take great pleasure in their dolls, puppies, and baby chicks. This is not too early to begin the study of reproduction of life. Children will accept it as a natural process, in the same way that eating and breathing are

natural processes. Questions asked by children should be answered immediately and frankly with no hedging or avoidance.

The element of conservation should be emphasized. Unless they are otherwise trained, children are apt to pick the flowers they see and to collect eggs. The teacher should point out to them that if the flowers are picked other people cannot enjoy them and that the plant will be unable to make seeds. It may then happen that there will be no flowers in following years.

SCIENCE MEANINGS FOR CHILDREN

Chickens and frogs hatch from eggs.

All life comes from life.

All young plants and animals have parents.

When parents do not care for their young, many are produced.

PROCEDURE

In connection with page 163 the teacher might suggest such leading questions as Where do new frogs come from? and Where do new plants come from? The reading should be followed by a trip to see frogs' eggs, to see eggs in birds' nests, to see new plants. The teacher will find some of the following activities helpful in developing the meanings listed above.

OTHER ACTIVITIES

1. Gather a few frogs' eggs from the pond and place them in a large jar of pond water. It is necessary to use only a few eggs for this purpose. After the polliwogs are hatched, observations might be made to note the development of the young frogs.

2. If it is possible to see baby birds in a nest, the children might study them closely to see how they resemble the mother.

3. Various kinds of flower seeds might be displayed in the classroom together with pictures of the flowers.

4. Various flower seeds might be planted in boxes of loam. They should be placed in sunlight and watered regularly. Many plants grow from seeds. Seeds are small plants that will grow into large ones when they are planted in good soil and are supplied with heat and water.

5. Collect pictures of baby animals and of baby animals with their parents.

6. Make a chart of baby animals that look like their parents, and another one of baby animals that do not look like them. There is great variation in living things.

Pages 165-167. Spring in the City Park. Often people do not realize that a city park offers a surprising variety of wild life that may be studied and observed. Invariably birds, frogs, cocoons, and turtles may be seen by the children even though they do live in the city.

It is the responsibility of the school to acquaint children with the facilities that a city offers. Perhaps the class might select a park, or a part of the park, they might call their very own. They might become observant enough to note even small changes that occur there: the budding of the trees, the buds bursting into leaves, the grass becoming greener, the nesting of birds, laying of eggs, raising of young, the growth of flowers.

PROCEDURE

Berries is a new word, the meaning of which might be developed during a discussion of what birds eat and why they are in the park.

The general procedures and activities suggested in the sections immediately preceding this are applicable here.

Page 168. Can You Tell? The questions on these pages may be used as a review of learnings or to make children more fully aware of the happenings going on all about them.

The answers to the questions are as follows: (1) frogs, turtles, snakes, moths, butterflies, certain kinds of birds, insects; (2) violets, lilacs, crocuses, trillium, tulips, skunk cabbage, iris, and others according to the locality.

Page 169. Watching the Seasons. Children will have ideas about all the questions suggested on this page. They enjoy answering and discussing questions about which they already have some information.

The answers to the questions are as follows: (1) winter; (2) spring; (3) spring; (4) the grass turns green, buds burst into leaves, fruit trees blossom, flowers begin to bloom; (5) autumn and summer (late); (6) by storing food, feeding to prepare for hibernation, migrating to a warmer climate, digging into the mud, spinning a cocoon; (7) answers will vary.

FILMS

Three Little Kittens
Snapping Turtle
Farm Animals

Moths
Frog
Butterflies

Robin Redbreast
Poultry on the Farm

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FITZPATRICK, F. L. *The Control of the Organisms*. Teachers College, Columbia, 1940.

SEARS, PAUL B. *Life and the Environment*. Teachers College, Columbia, 1939.

YOCUM, L. EDWIN. *Plant Growth*. Cattell, 1945.

X. THE STORY OF A PLANT

Pages 170-175. **The Story of a Plant.** Although children will have seen plants growing in their homes, in the school, and in gardens, they will not have developed the over-all meanings connected with plant study, such as the relationship and interdependence of living things, the adjustments and adaptations of plants for survival. Children should be made aware of the tremendous struggle for existence that living things are engaged in. In the case of the plant in Alice's schoolroom the thought is developed that even though conditions are very bad, the plant continues to grow when light and moisture are supplied. During discussions about plants some of the children will make dogmatic assertions, others will deny such statements, and still others will withhold judgment and wait until they have experimented before they arrive at conclusions.¹

SCIENCE MEANINGS FOR CHILDREN

Plants need water, heat, and light.

Too much water kills a plant.

Plants may be revived when right conditions are present.

Plants are adapted for living.

PROCEDURE

This chapter will be used most at a time when children are concerned with their own planting. Before reading pages 171-172 the children might offer opinions as to what their plants need. Let them read these pages to check their own plans or to find better ways.

Before finishing the story of the sick plant on pages 172-175 they might try to predict what the plant needs. If the children have had experiences in providing conditions necessary for plant growth, they may now be able to generalize as to what the plant needs. Now have them read the story to check their ideas and to

¹For further information on plants see *Science for the Elementary-School Teacher*, p. 111.

see how the children in the book helped the sick plant. Note the condition of the plant as described on pages 173, 174, and 175.

The teacher might plan an activity similar to the one described in the book by setting a plant in a dark place and not watering it. She might call the attention of the class to the plant and then ask for suggestions as to how it might be made healthy again. Various suggestions will be made. The children will have to appraise the ideas offered and select the procedure which they think will be most effective. As the experiment gets under way, the reading of the text might take place. However, care must be taken to introduce new words which the children will meet in their reading. See new words listed on page 224.

Throughout the reading and discussion the teacher will find many of the following activities useful in explaining ideas and proving statements.

OTHER ACTIVITIES

1. Make tree boxes and plant various seeds of trees in them. In some cases it may be desirable to dig up a seedling with two or three years of growth and to plant this in one of the boxes. Place the boxes in sunlight and water them regularly. Observe closely to notice signs of growth. Plants need warmth, light, and moisture for good growth.

2. To show that some plants grow from seeds, line glasses with blotting paper and fill them with sand or sawdust. Place lima beans between the paper and the glass. If the sand is moistened, the seeds will sprout. Observe that the roots grow downward and the stems grow upward. The teacher might have other beans soaking so that the children may take them apart to see which part of the seed becomes root and which part becomes stem. Note also that a large part of the seed is made of food stored up for the young plant.

3. To show that some plants grow from bulbs, place a large onion on top of a tumbler of water so that the root end reaches into the water. Which starts growing first, the stem or the root? Narcissus bulbs may be grown in a similar manner.

4. On a field trip the children may select a plant they wish to observe at intervals. Through subsequent observations they will notice how the buds become flowers, the flowers wilt, and the seeds are formed.

5. To show that plants may grow from slips, place willow twigs, pieces of geranium, and cuttings of ivy in water. They should be in clear glass containers so the children may see signs of growth. Plants may be grown from seeds, bulbs, or cuttings.

6. Place a few potatoes in the dark and leave them there until sprouts appear on them. From which part of the potato do the sprouts grow? Of what use is the rest of the potato to the young plant?

EVALUATION

The manner in which the children enter into activities, make suggestions and carry them out, and ask questions and then look up the answers may be used for purposes of evaluation. Are the children becoming more scientific in their attitudes? Are they willing to listen to new ideas? Do they accept these ideas gullibly, or do they seek to corroborate them through reading, observation, and experimentation? Do they question the procedures used in experiments? Do they check their findings with authorities?

The teacher will find it helpful to keep these ideas in mind and to apply them to specific situations. For example, in an experiment seeds may have been planted at different depths, whereas they should all have been planted at the same depth. If a child is alert enough to note this error, that child is growing, and recognition should be made of his suggestion when evaluating.

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CRAIG, GERALD S. *Science for the Elementary-School Teacher*, Chaps. X, XII, XIII. Ginn, 1940.

BALTHUS, FREDERICK. *Plants in the Home*. Macmillan, 1941.

WEATHERWAX, PAUL. *Plant Biology*. Saunders, 1942.

FILMS:

Plant Growth*

Gardening

*Films so designated are somewhat advanced in comparison with the text, but may be useful for some groups.

XI. MAKING THINGS WORK

This chapter may be used at any time during the year. It does not necessarily depend upon preceding chapters. However, it will be wise to give attention to new science words listed for these pages on page 224.

Children are interested in things that are moving. Mechanical toys interest them. When they are shown a toy train, they want to see it move over and over again. After a time their interest becomes so great that nothing but their running the train themselves suffices; they want to be a part of it. This section utilizes such interests of children and at the same time gives explanations of why things move.

Things do not start moving of their own accord, but something makes them move. Gasoline causes a car to move, wind turns a windmill, the burning of coal moves a steam engine, a push moves a toy wagon. Here is the application of a basic law of science, that there must be a cause for everything that happens.

CONTENT

Power and its control has brought about our present civilization. As man has learned more about power, his way of living has become more comfortable and convenient. While wind and water power are not used extensively in a direct manner, they are used to produce electricity. Electricity is becoming more and more popular as a basic source of power, for it is convenient and clean, and it is becoming cheaper as engineers learn more about it.¹

It may be that atomic power will someday replace some of the kinds of power that are used today; but that day appears to be a long way off. In any event it will be some time before atomic power becomes available to the ordinary person.

Pages 177-178. The Wind Moves Many Things. Children have seen the wind move leaves, grass, and trees; and they have seen it blow so strongly that it bent the trees and even broke them.

¹See *Science for the Elementary-School Teacher*, Chap. XIX.

That the wind makes the waves on ponds, lakes, and seas may be a new idea for most children.

Before having the children read page 177 give them time to discuss ways they know in which the wind moves things. Let them study the picture on pages 176-177. List all the ways they know for a new science reading story. Now have them read to compare their story with that on page 177.

Let the children try Jack's experiment described on page 178. Ask them, "What does your experiment prove to you?"

OTHER ACTIVITIES

1. Make a trip to a pond to see how the wind makes waves. If there is no wind blowing, the children might put their mouths near the water and blow. Small waves will be formed. While going to the pond, they might observe other things that the wind is doing.

2. The children might make a reading chart that will provide a dynamic reading experience, such as the following:

What the Wind Does

It moves the leaves.

It moves dust and dirt.

It moves the soil.

Wind makes the waves.

Wind moves the clouds in the sky.

Pages 179-181. **The Wind Is Strong.** To prepare themselves for the next section on the work of the wind, the children will need to know that the wind is very strong. The pictures will suggest illustrations of the strength of the wind. The one showing the policeman helping Alice serves to emphasize the point that policemen are nice to people, that they are anxious to help people, and that their sole purpose is not to arrest them. Here is a social situation in which the teacher may note the attitudes of children toward others.

PROCEDURE

Give the children an opportunity to say why the wind is strong in the picture on page 179. After introducing the new word *strong* by writing it on the board, have the children read page 179. The ideas in this section will provide a departure for a discussion of other ways in which the strength of the wind is exhibited. Thus the force of the wind may be seen in (1) the very high waves on the ocean, that are sometimes higher than our classroom; (2) the uprooting of trees; (3) the laying flat of fields of wheat; (4) the collapse of buildings.

OTHER ACTIVITIES

Kites may be built by fastening two light strips of wood in the form of a cross (24" and 18") and covering them with newspaper. (See Fig. 6.) The shorter strip should be bent like a bow by fastening a string to the ends. The kite string should be fastened to the joint. To secure stability, a tail of rags may have to be fastened to the bottom of the kite. When children fly the kite, they will feel the pull on the string. The pull is caused by the force of the wind and moving air.

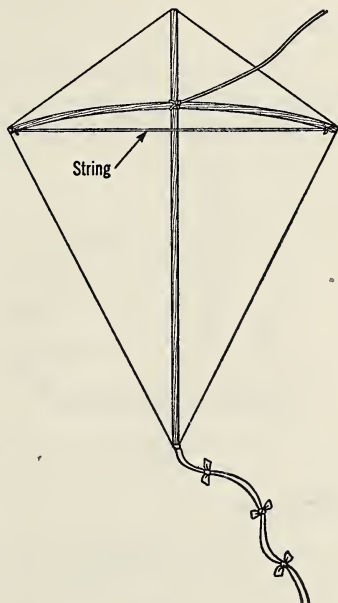


Fig. 6

Pages 182-185. The Wind at Work. In the early days of man he did all his work by using only his own muscles. As he progressed, man learned to make use of the muscles of animals, and still later he developed ways of utilizing other sources of power, such as the wind. The great force of the wind was discussed in the

previous section. Here we learn how man applies that force to his needs. As far as possible have the children experience the ideas suggested in the text.

CONTENT

Windmills are now used not only to pump water but also to charge batteries for home radio sets. At Grandpa's Knob in Vermont, experiments are being carried on to see if electricity can be made on a commercial scale by using the power of the wind.

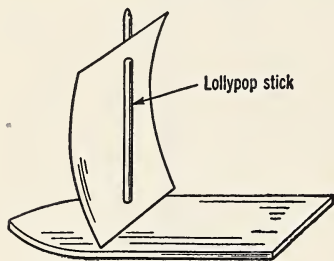


Fig. 7

Wind-propelled ships are becoming obsolete because the wind is often erratic, which fact makes it impossible for shipping companies to keep time schedules. They are therefore using steam or gasoline to move their vessels.

PROCEDURE

After reading pages 182-183 try to visit a windmill. Observe that there is a shaft connecting the vanes to a pump or to an electric generator. Notice how only a light breeze turns the windmill and causes water to be pumped to the surface.

After reading page 184 the children might make small sailboats, such as that shown in Fig. 7, and take them down to the pond to sail them. If no pond is near by, the teacher might bring in a large washtub in which to sail the boats. Blow on the sails to see how wind makes the boats move.

OTHER ACTIVITIES

Build a science reading chart that will make use of the learnings of the children, and that will serve to present again the new words.

*Work Done by the Wind**The wind pumps water.**The wind makes electricity.**The wind carries odors to animals.*

Pages 186-187. **Water at Work.** Before reading pages 186-187 see what conception children have of time and change in the historical sense by using the pictures on pages 186-187. It is not likely that many of the children will have seen a water wheel at work, but the teacher can discuss how it was employed in the early history of industry. That moving water exerts a great force can be shown by its erosive effect, by the force of the waves as they wash against the shore, and by the way in which a stream is able to roll rocks along the bottom.

PROCEDURE

The community might be explored to see if there is an old mill that might be visited for the purpose of examining a water wheel. Perhaps it will be possible to go to an electric generating station to see water at work. As listed on page 224 of the text there are many new words on these two pages. Before reading, the teacher may find it helpful to introduce them in their context. Any time spent in such preliminaries is well spent, for it will insure a pleasant reading experience.

OTHER ACTIVITIES

If there is a rather fast-moving stream in the locality, a water wheel similar to the one shown in Fig. 8 might be built and mounted in it. To make a water wheel use a wooden disk. Cut notches and attach thereto wooden blades as shown. If there is no stream, a smaller wheel might be made. It can be turned by pouring a stream of water on the blades. Discuss how man harnesses the movement of the wheel to his needs. Such wheels are not used directly for power, but are made to turn generators

which produce electricity. This is more practical, for electricity can be used two or three hundred miles away from the place where the power is generated; when used directly, the power must be used at the place of origin.

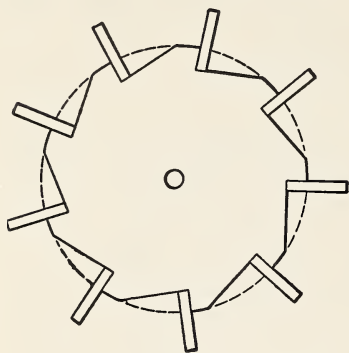


Fig. 8

Pages 188-189. Electricity on the Farm. Even though electricity may not be used on the farms around the school, children should know of its value to farmers. The world is very large. There are many communities. Some of them enjoy the benefits of electricity; others are not so fortunate.

SCIENCE MEANINGS FOR CHILDREN

All people at one time had to use oil lamps.

Electricity is now available to many farmers.

Wise use of natural power will make electricity available to all.

PROCEDURE

Before letting the children read pages 188-189 have them note the lamp, lantern, and electric lights in the picture on page 188. Ask, "How else does Joe's father use electricity on his farm?" See the picture on page 189.

If electricity is common in your community, the children might discuss how they believe things would be if there were none. Ask them, "How would your life be different? How do you use electricity?" If many of the homes and farms do not have electricity, the teacher should discuss with the children ways in which it might be made available. The work done in the Tennessee River valley might be mentioned here, as well as the projected work in the Missouri River valley, if the children live in or near these regions.

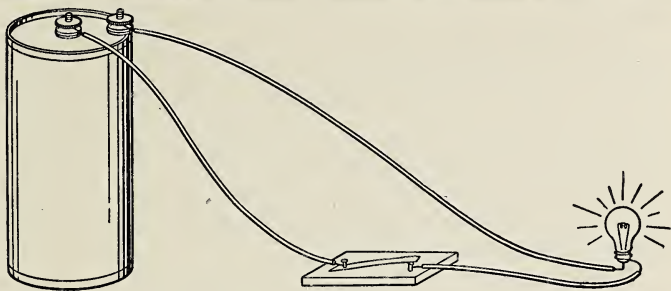


Fig. 9

There are many new words on these pages (see listing on page 224). The teacher will find that reading will be more enjoyable if these words are written on the board and discussed prior to individual work.

OTHER ACTIVITIES

There are many activities that can be carried out in connection with the study of electricity.¹ The number of activities used will depend upon the maturity, interest, and readiness of the group.

1. Wire a dry cell to a small bulb so as to show that there must be a circuit (circle) for the electricity to flow.

2. Place an ordinary homemade switch in the circuit, as illustrated in Fig. 9, so that the electricity may be turned on and off easily. The switch is made from wood, a strip of tin, and two nails. When the tin is down, the bulb will light.

3. These activities may be applied if the children have a play-house which they desire to supply with light.

Pages 190-191. Steam at Work. Most children will have seen a steam locomotive, or a steam engine. It should be an easy matter to develop the feeling of power produced here. How very long the train is! The train must weigh a great deal; yet the engine can move it easily.

¹See *Science for the Elementary-School Teacher*, Chap. XX.

PROCEDURE

Before reading pages 190-191 see if the children can suggest how steam is used to move things. As the children examine the picture on pages 190-191, note how they generalize about steam, clouds, smoke, and burning. Have the children reread pages 114-116, 126-127, 130-133, and 134-135 if their ideas are not clear.

The children might talk about various trains they have seen. They might compare information about where they go to, how many cars they have, and so on.

They may want to gather pictures of steam engines and place them on a large poster, and visit a railroad depot to see an engine.

Pages 192-196. Horses and Tractors. It is hoped that children will have acquired a feeling of protection for animals such as that exhibited by Joe. Not only must we take care of domestic animals, but also the wild creatures in the woods, fields, and brooks.

Children are apt to feel that the things they see about them have always been as they are. It is often a revelation for them to find that at one time there were no tractors and all farm work was done with horses. Man's way of doing work is constantly changing as his knowledge and his ability to apply it increase.

The introduction of the machine into farming does not relieve the farmer of the responsibility for conserving (using wisely) those things available to him. As with living things, machines will also waste away and become useless if they are not cared for.

PROCEDURE

The ideas discussed on these pages should provide excellent departures for discussions. Discussions about farming long ago, about how to care for machinery, about how to care for animals, about controlling rust, might well be carried on.

Before reading the material, the teacher should acquaint the children with the new words they will meet. There is a listing of these words on page 224 of the text.

OTHER ACTIVITIES

1. Coat some of the nails with grease. Do they rust as badly as the untreated ones? Grease protects iron from the weather.

2. Instead of placing the nails in water, put them into a jar with a damp sponge. Do these nails rust? Do nails have to be in water to rust? This activity will show that rusting takes place when iron is damp, not only when it is wet.

Page 197. Something for You to Find Out. The questions and illustrations encourage children to find out more about their surroundings. The answers will vary, but they may be: (1) an electric plant, automobiles, tractors, trains, electric pumps; (2) at the electric plant we saw big wheels turning, steam clouds coming from the pipe, a friendly man who talked to us.

EVALUATION

Misconceptions may be revealed. Children should not be penalized for having wrong ideas. In this section, the teacher might keep in mind the following ideas as bases for evaluation: (1) Do children take care of their toys and materials? (2) Are they gaining some idea of the importance of power to man? (3) Are they kind to their pets and to wild creatures? (4) Do they realize that things are constantly changing?

The teacher may wish to determine the factual learning. Write the sentences on the board, putting a blank line in place of each italic word. Let the children supply the omitted words.

1. Our grandfathers used only *horses* on their farms.
2. Today farmers use *tractors* on their farms.
3. Horses must be given *food* and *water*.
4. When iron gets wet, it will *rust*.

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FILMS:

Passenger Train

Horse

XII. ANIMALS ON THE FARM

Page 199. Alice Visits the Farm. This is a natural occurrence in the lives of children. Perhaps, if the school is in the country, some of the children may have had their cousins from the city as guests, and they will want to tell about them. Did the cousins know about the animals on the farm? Did they know of things in the city that are different from those in the country? This section prepares for the experiences that are to come in the chapter.

The children might read it and then discuss the ideas. Do any of them help by milking the cows? Do they pick berries for Mother?

Pages 200-203. Bullsnares Live on the Farm. In many cases children have been trained, from the time they could understand, to kill all snakes. Alice's suggestion on page 200 to kill the bull-snake is therefore to be expected. When children are aware of the good that snakes do, they are not so apt to kill them. The teacher, however, should not be discouraged if at first the children do not change their reactions.

The principles that there is great variety in living things and that all life comes from life might be developed here. The teacher might also bring out (1) that in the animal world when the young are well cared for there are but few offspring and (2) that when the young are not cared for there are many.

SCIENCE MEANINGS FOR CHILDREN

Most animals are helpful to man.

Most snakes are helpful to man.

Bullsnares eat rats and mice.

Bullsnares stay under rocks in winter.

Bullsnares lay eggs.

Bullsnares do not care for their young.

PROCEDURE

After reading pages 200-203 the teacher might desire to discuss the ideas presented. She might ask these questions: "Have

you ever seen a bullsna^ke like the one shown in the pictures? Did you hurt it? Do you think you should have hurt it? Why not? Have you ever seen baby bullsna^kes? Do you think we could see one if we went for a walk?"

The children will be anxious to explore the fields in search of snakes and signs of them. It may be that you will be unsuccessful in finding any; but the children should be encouraged to be on the lookout for one. Those that have seen a snake might tell the class what it looked like, what it was doing, where they saw it, and so on. In their explorations they might see other snakes and, in the same manner, tell about them.

OTHER ACTIVITIES

If closer observation is desired, a snake might be kept in the classroom for a few days. As suggested earlier in this Manual, snakes should be kept in terrariums rather than in wire cages, for they often hurt themselves against the wire. Snakes should be fed insects or pieces of meat. Since most snakes do not do well in captivity, it is desirable to release them after one or two days.

Pages 204-206. Skunks Live on the Farm. Some children, because of the actions of adults, want to kill all animals they see, even skunks. It is the work of the elementary school to inform all the people that living things, since they are equally endowed with life, have a place in the world. The habits of most animals are such that they are helpful to man. As stated in the book, skunks are believed to eat eggs. Joe's father, realizing this, builds a henhouse that a skunk cannot enter. He now has the advantages of a skunk around to eat mice and insects, and he does not need to worry, for he knows the skunk cannot do any damage. In a similar way man should learn how to live with other living things in his environment. There is a balance of nature that serves to keep living things in control. When man upsets this balance by killing off some form of life, the results may often be disastrous. Children should be trained to realize that it is good to have animals about the farm, that they should be kind to them, and that they should learn to live with them.

PROCEDURE

Use the picture on page 204. The children may have seen skunks, and some may have had experiences with them. Allow them to tell about these. During the discussion, to acquaint the children with the new word *skunks*, the teacher might write on the board "Skunks live on the farm." The teacher might also emphasize that the odor of a skunk is a protection against enemies. Other animals have means or ways of protecting themselves, such as claws, fleetness, coloration, fangs. Animals are adapted to their surroundings. There is great variety among living things.

Pages 207-208. **Owls Live on the Farm.** The ominous staring and deep-throated voice of owls often tend to frighten children. The fear is built upon erroneous information and is soon dissipated when the truth is known. In some cases owls have been used by unthinking parents to take the place of the bogeyman: "The owl will get you if you're not good." Such a conception once established in a child's mind is difficult to overcome and to replace. The teacher is helping to do so, however, when she teaches that owls are good, that they help us by eating mice that eat the farmer's grain, and that they do not harm man at all.

SCIENCE MEANINGS FOR CHILDREN

Owls eat mice.

Owls are helpful to man.

Owls lay eggs.

PROCEDURE

Perhaps some of the children will know where there is an owl family that the children might visit. Perhaps they will wish to gather pictures of other kinds of owls and mount them on a large chart. (There is great variety in living things.) The chart might be made more valuable by lettering on it the ways in which owls help man.

Page 209. **The Animals on the Farm.** These questions serve to review the learnings and to emphasize that when we know the

truth many wrong ideas are corrected. The answers to the questions are as follows: (1) bullsnake, skunks, and owls; (2) by eating rats and mice; (3) it slept under rocks; (4) it sunned itself on the rocks and got ready to eat mice; (5) by eating mice and insects; (6) by eating mice; (7) rats, mice, and insects.

Page 209. Something for You to Think About. This section gets at the essential facts in this area, which may be summed up thus: (1) most animals are helpful to man; (2) we should help animals; (3) we should not hurt them. The answers to the questions might be as follows: (1) snakes, skunks, owls, and others; (2) yes; (3) let them alone, and do not destroy their homes; (4) rats, mice, cockroaches, and so on.

EVALUATION

As mentioned previously, the teacher cannot hope to overcome in a few hours of instruction ideas that have been imbued in children from the time they were able to understand. For instance, if they have learned that skunks eat eggs and should therefore be killed, the idea cannot be corrected easily. However, when the truth is known, children may gradually grow toward an attitude that has logic behind it. Are the children coming to believe (1) that animals are helpful to man, (2) that we must learn to live with our animal friends, (3) that animals must struggle to survive and we must help them, (4) that there is interdependence among living things—animals depend on man, man depends on animals?

The children may wish to make a list of those animals that they know to be helpful and another list of those they know to be harmful. The lists may be illustrated with pictures found in magazines or with pictures drawn by themselves.

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FILMS: Farm Animals

Poultry on the Farm

Goats

XIII. A VISIT TO THE FOREST

The trees in the forest, like all other plants, are of value to man. Even weeds have a place in the balance of nature. When land is denuded by man and made worthless, weeds begin to grow. The many seeds produced make for a rapid covering which keeps the soil from being further destroyed. Weeds are sometimes called "pioneer plants," for they are the first to occupy a region.

Trees are a valuable farm crop, and will probably become of even greater economic use. Wood, in addition to being used as lumber, is now employed in the making of rayon and other synthetic fibers and also in the making of plastics, paper, and even foodstuffs. Farmers are gradually learning that a wood lot is not a liability but an asset of enviable value readily turned into cash.

Pages 211-216. The Forest Is Useful. Unless the value of trees is pointed out to children, they are likely to take trees for granted. The trees were there when they were born; hence there is no reason to expect that they will not continue to be there. Children do not always realize that trees are plants, that they are alive and growing just as they themselves are living and growing. The beauty of a stand of trees is often lost to the observer, for he has not developed an appreciation of the age of the trees.

The teacher should strive to instill a feeling for trees and forests. When children know the truth, when they know the value of trees to man, their appreciation becomes greater. Perhaps concepts developed here will be further developed as the child matures, and he will become instrumental in effecting conservation practices. A country is only as rich as its resources. Man must be educated to the meaning of this statement.

SCIENCE MEANINGS FOR CHILDREN

Trees grow.

The forest is useful.

As trees are cut down, young ones should be planted.

Forests keep the soil from washing away.

Forests keep the soil moist.

PROCEDURE

Before letting the children read page 211 have them look for young trees in the picture of the forest on page 210. Ask them, "Do you know a place where young trees are planted or allowed to grow? Could you plant some young trees on your school grounds?" Now let them read to see why Father wanted Alice and Joe to go with him to the forest.

Let the children try to answer Joe's question on page 212 before reading to see what Father said.

Although discussion and reading may be effective, they will not have as much meaning as a walk through the forest. The teacher should plan an excursion so the children may see various stages in the growth of trees, from a tiny seedling to a tree with a few years' growth and finally to a tree of full maturity. While in the woods the children might see a stump on which they could count the rings to learn how old the tree was.

The children might dig down under the leaves, as Joe's father did, to see that the leaves keep the soil from drying out. Plants can grow because of this moisture.

If possible, it is advisable to take the children into the woods while it is raining. They can see how the leaves on the floor of the forest act as a sponge and thus keep the water from running off. At the same time the teacher might take the children to a place where there is no foliage on the ground so they may see how, if there is no covering, the water runs along rapidly, carrying soil with it. Trees act to keep the soil from washing away.

The teacher might emphasize the balance of nature. Trees have a place in the scheme of things. When they are cut down, as they were in the developing of the Mississippi Valley, dire results are brought about. In this connection the children might discuss ways in which man is trying to correct the harm brought about by reckless harvesting of trees.

OTHER ACTIVITIES

1. The children might place a mound of earth and rocks in a sand box and plant grass on it. If kept damp for a few days, the

grass will sprout. After the grass has established a good root growth, water might be poured over the mound to show how a cover holds the soil from being washed away. At the same time there might be a mound without any grass on it. When water is poured on this, the soil washes, making gullies and fissures.

The teacher should emphasize that water is held back in forests because of the spongy vegetable material that covers the ground and because the roots of the trees tend to hold it.

2. The children might make a list of the value of forests to man. The list might include such ideas as these: (1) Forests supply us with wood to burn; (2) Wood is also used to make buildings; (3) Trees give us fruits and nuts; (4) Forests hold the soil; (5) Forests make cool spots for picnics.

Pages 217-219. Some Animals Need the Forest. Plants and animals are interdependent; there is an interrelationship among all living things. If the woods are cut down, many animals that make their homes there have no place to live. Children are quick to see the implications of such a situation.

In discussing the forests the teacher should emphasize that they are to be used, but that the use must be planned. Conservation means using wisely those resources that are available. It does not mean saving them for future generations. The fact is that forests do better when some of the trees are taken out. Tall trees that have reached maturity should be removed, for they shade the younger trees, either causing them to die or retarding their growth.

Let the children answer Alice's question on page 219 as to where the animals would go if the trees were cut down.

SCIENCE MEANINGS FOR CHILDREN

Plants help animals.

Animals help plants.

The forest is the home of many animals.

Forests should not be cut down.

Young trees should be planted.

Trees hold the soil.

PROCEDURE

The children might discuss other animals besides the deer that live in the forest. The teacher might ask, "Why do they live there? What would happen to them, where would they go, how would they live, if there were no forest?" The teacher might arrange to have the children walk through the forest to see wild life or to see signs of living things. They might see the nests of birds or squirrels, the tracks of animals, bits of fur caught on brambles.

It is better to hold the discussion and to take the field trip prior to the reading. During these activities many of the words that the children will meet in their reading will have been used; thus an acquaintance with them will have been acquired.

OTHER ACTIVITIES

1. Children may make a chart of animals that live in the forest. The chart would include birds, deer, rabbits, squirrels, and foxes.

2. They might also make a chart of ways in which the forest is helpful to animals. This chart might include such ideas as these: (1) It provides them with food; (2) It provides them with protection from their enemies; (3) It is cool; (4) It provides homes.

EVALUATION

It takes a long time for children to realize that all living things are interdependent; but the small beginning made here should be extended in later grades so the child will gradually acquire an appreciation of the concept. The children might be more observant of illustrations of the ways plants and animals help each other. They might consciously try to plan ways in which they can help animals. They might put out food for them and also materials from which birds may build nests.

Are children growing in resourcefulness? Do they use all the materials with which they are working, or do they plan their work so some will be left for another occasion? This is conservation. Conservation is wise use; it is planning; it is being resource-

ful. There is just so much of a substance to go around; if it is completely used up, there is no more to be had.

Page 220. Come Again. Here Alice is made to feel that she is important, that her visit to Joe's farm has been a real help. Children in the classroom can be given this feeling, and the teacher should strive to develop it. We need to discover more ways in which children can do a fair share of work at home, at school, and in the community.

Before reading page 220 let the children recall how Joe and Alice have helped with the work on the farm. Has reading these science stories helped children to look forward to visiting a near-by forest? Have they had an opportunity to participate in useful and needed work at their age level?

Page 221. Something to Think About. The answers to these questions might be as follows: (1) because they are a good crop, they hold back the soil, they prevent floods, they provide homes for animals; (2) they soak up the water so it does not flow fast down the banks; (3) the roots hold the soil together; (4) they give them food, homes, and protection; (5) because they are large and cannot dig holes to live in, because they live in trees; (6) no, because he knows that they are good to have.

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FILM

Common Animals of the Woods

APPENDIX

Materials Needed in Science through the Year

Adhesive tape	Glass (reading)	Sandpaper
Balloons	Glass plates	Sand table
Balls	Globe (large)	Seeds
Beans	Hammer	Shellac
Blotters	Jars (large)	Ships
Bulbs (plants)	Lumber	Slide projector
Cage (wire)	Nails	Straws (soda)
Calendar (large)	Pail (large water)	String
Candles	Pans (small and large)	Teakettle
Dry cells	Paper (brown kraft)	Terrarium
Electric hot plate	Paper (poster)	Thermometer (large)
Flashlight	Plants (varied)	Toys (boats, dolls, blocks)
Flower boxes	Poster paints	Wax (paraffin)
Glass (drinking)	Potatoes	Wire (bell)
	Pots (for plants)	

Bibliography for the Children

The following list includes picture books and simple storybooks which may be used with children who are using *Science through the Year*. In selecting these books the authors have attempted to list those which are free from fantasy and personification. The more difficult books should be read aloud to the children.

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List of Publishers

APPLETON. D. Appleton-Century Company, Inc., 35 West 32d St., New York, N. Y.

CATELL. Jacques Cattell Press, North Queen St. and McGovern Ave., Lancaster, Pa.

COLUMBIA. Columbia University Press, 2960 Broadway, New York 27, N. Y.

DODD. Dodd, Mead & Company, Inc., 449 Fourth Ave., New York 10, N. Y.

DOUBLEDAY. Doubleday & Company, Inc., 14 West 49th St., New York 18, N. Y.

DUTTON. E. P. Dutton & Co., Inc., 300 Fourth Ave., New York 10, N. Y.

GINN. Ginn and Company, Statler Building, Park Square, Boston 17, Mass.

HARCOURT. Harcourt, Brace and Company, 383 Madison Ave., New York 17, N. Y.

HARPER. Harper & Brothers, 49 East 33d St., New York 16, N. Y.

HOUGHTON. Houghton Mifflin Company, 2 Park St., Boston 7, Mass.

INTERNATIONAL. International Publishers Co., Inc., 381 Fourth Ave., New York 16, N. Y.

KNOFF. Alfred A. Knopf, Inc., 501 Madison Ave., New York 22, N. Y.

MACMILLAN. The Macmillan Company, 60 Fifth Ave., New York 3, N. Y.

MORROW. William Morrow & Co., Inc., 425 Fourth Ave., New York 16, N. Y.

OXFORD. Oxford University Press, 114 Fifth Ave., New York 11, N. Y.

RAND. Rand McNally & Company, 536 South Clark St., Chicago 5, Ill.

RANDOM. Random House, Inc., 20 East 57th St., New York 22, N. Y.

SAUNDERS. W. B. Saunders Company, 218 West Washington Square, Philadelphia 5, Pa.

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Films

The films mentioned in this Manual are produced and distributed by Encyclopaedia Britannica Films, Inc., 20 N. Wacker Drive, Chicago 6, Illinois. Other educational films are available, produced and distributed for sale or rental by a number of agencies. These films are listed and classified, with brief descriptions, in a monthly cumulative catalogue, *Educational Film Guide*, compiled by Dorothy E. Cook and Eva Rahbek-Smith and published by the H. W. Wilson Company, 950-972 University Avenue, New York 52, N. Y.

There is of course a considerable range in the effectiveness of films, and no film should be used in the classroom on the basis of title or brief description only. The teacher should become familiar with the content of the film and its suitability for classroom instruction before it is secured. In the case of films produced to illustrate industrial products or processes, one should scrutinize them for any possible objectionable advertising.

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